SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

NOVEMBER 1899.

GENERAL PHYSICS.

1617. *Elastic Properties of Steel Wire.* **A. D. Keigwin.** (Instit. Civ. Engin. Proc. 136. pp. 3–9, 1899.)—The effects of wire-drawing and annealing on the stress-strain diagram of steel wire are here experimentally studied. The conclusions are: 1. Steel when wire drawn has its breaking load increased. 2. When the wire is annealed the breaking load is lowered to that of the billet from which the wire was drawn; in this case an average reduction of 39 per cent. 3. The ratio of yield point to breaking load (36·7 and 31·8 per cent. for unannealed and annealed wires respectively) is lowered. 4. The ratio of the extensions at yield point and at breaking load in unannealed wire, viz., 0·25 to 0·75 per cent., is increased by annealing to 0·25 to 5 per cent. 5. The reduction of area of break is increased 16 per cent. by annealing. 6. The mean stress-strain diagram for annealed wires is a parabolic curve. J. B. H.

1618. *Young's Modulus by Interference-Method.* **G. A. Shakespear.** (Phil. Mag. 47. pp. 539–556, June, 1899.)—Three wires, at equal distances from each other, are attached at their upper and lower extremities to metallic discs, the points of attachment being capable of adjustment. Part of the interference-apparatus is placed on the centre of the lower disc, and part on a suitable stationary support near the centre. The advantage of the adjustable triple suspension is that, when the wires are stretched, the movable part of the interference-apparatus moves parallel to itself. The load is applied without any shock with the aid of a cylinder, pointed at each end, originally immersed in water; removal of water from the containing vessel increases the load, addition diminishes it.

The behaviour of the wires at various temperatures is studied by surrounding them with jackets of the vapour of water or other liquid, produced at various pressures. Temperature has a remarkable effect on the value of Young's Modulus. In the case, for example, of a specimen of copper, which had rested for some time, it was *increased* by 4·4 per cent. on *first* heating the wires from 13° to 100°; but on allowing them to cool to 13°, and again heating to 100°, there was a contrary behaviour, a *decrease* of 2·3 per cent. taking place. A third heating produced a greater decrease. Ultimately, after successive heatings and coolings, the the copper behaved in a consistent manner, the decrease on heating being about 3·6 per cent. Specimens of soft iron and silver steel showed similar but less decided characteristics.

The paper also contains accounts of experiments on the effects of the magnetic field on the elongations and contractions of iron and steel under various conditions. A. Gs.

1619. *Deflection by Small Loads.* **C. P. Weston.** (Phys. Rev. 8. pp. 297–303, 1899.)—A bar, supported at each end, about 60 cm. long, and 1 cm. × 0·5 cm. cross-section, has part of an interferometer attached to its centre. It is loaded by weights of 0·5, 1·0, 1·5, and 2·0 gms., and the deflections are deduced from the movements of the interference bands. The same bar is loaded by weights up to 200 or 250 gms., and the deflections noted by means of a microscope. With steel, copper, and brass bars the ratios between the small and large deflections are, within the limits of the possible experimental errors, as indicated by theory, *i.e.*, Young's Modulus is the same for the feeble as for the greater strains. A. Gs.

1620. *Elasticity of Glass.* **R. Straubel.** (Wied. Annalen, 68. 3. pp. 369–413, July, 1899.)—That the "elasticity ratio," or the ratio of sectional contraction to longitudinal dilatation, has the value 0·25 for all isotropic bodies, has already been made very doubtful by a number of experiments, although those made on metals are not conclusive owing to the absence of definite proof of isotropism. Cornu's method of determining the elasticity ratio is capable of yielding accurate values if the dimensions of the prism are suitably chosen and the flexure is varied within wide limits. The elasticity ratios of thirty specimens of glass from the Jena glass-works range from 0·197 to 0·319 The moduli of compression, calculated from the moduli of tension and the elasticity ratios, lie between 3,070 and 7,520, and the torsional moduli between 1,840 and 3,290 kg. per sq. mm. A representation of the observed elasticity ratios as linear functions of the percentage by weight is feasible, with an average error of 1·7 per cent., and a maximum error of 5·6 per cent., but the values of the constants cannot all be satisfactorily determined. E. E. F.

1621. *Wrought Iron at High and Low Temperatures.* **R. C. Carpenter.** (Railroad Gazette, 30. pp. 808–809, 1898.)—The tensile strength of wrought iron or steel appears to be a minimum at about 70° F., and increases as the temperature is changed in either direction, becoming about 20 per cent. greater at about 500° F. and at 60° below zero. There are indications of a brittle region at the temperature of steam at 5 to 10 lbs. pressure. Iron at low temperatures, while increasing in strength, retains its ductility. In the case of cast iron the tensile strength remains constant from 70° F. to 700°, decreasing from that point to zero at 1,240°. J. J. S.

1622. *Surface Tension.* **H. Wallbott.** (Wied. Annalen, 68. 3. pp. 496–499, July, 1899.)—The author adduces what he claims to be the first direct optical demonstration of the component of the surface tension at right angles to the wall. It is placed in evidence by observing the interference fringes in the spectrum of light reflected by thin plates backed half by air and half by mercury. Sodium light shows a curvature of the air fringes towards the mercury fringes. The author describes several different forms of the experiment. E. E. F.

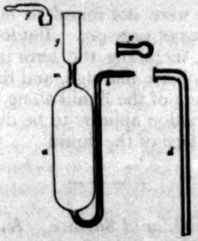
1623. *Viscosity of Liquids.* **G. Wetzstein.** (Wied. Annalen, 68. 3. pp. 441–470, July, 1899.)—The author investigates the variation of the viscosity of liquids under the influence of external pressure, with special reference to deviations from Poiseuille's law. Such deviations were not found to take place as a direct consequence of changes of pressure. But for increasing pressures the Poiseuille formula, including the term introduced by Hagenbach, gives values which are too high, and this deviation is most probably due to a sliding of the liquid along the inner walls of the tube. The external friction appears to be directly proportional to the pressure at the surface of the liquid. E. E. F.

1624. *Impact with a Liquid Surface.* **A. M. Worthington** and **R. S. Cole.** (Roy. Soc. Proc. 65. pp. 153–154, June, 1899.)—This paper is a continuation of a paper under a similar title, published in the "Philosophical Transactions," A. vol. 189, 1897. It contains further descriptions and explanations of the different phenomena experienced when a polished sphere is dropped into a liquid under different conditions as to height of fall, cleanliness of surface, &c. J. B. H.

1625. *Least Thickness of Liquid Films.* **K. T. Fischer.** (Wied. Annalen, 68. 3. pp. 414–440, July, 1899.)—Mercury has, on account of its high surface tension and slight miscibility, great advantages over water in experiments concerning the thinnest liquid films. If olive oil, dilute sulphuric acid, or a mixture of glycerine and water, are spread on mercury, continuous films are generated which may become thinner than 5 mm., or, in the case of the sulphuric acid, 1 mm., without breaking up into drops. But eventually they break up, and the thicker they are the more their breaking up is retarded. E. E. F.

1626. *Maximum Density of Solutions.* **L. C. de Coppet.** (Comptes Rendus, 128. pp. 1559–1561, June 26, 1899.)—The maximum densities of solutions of potassium, sodium, lithium, and rubidium chlorides were studied. The experimental arrangement includes a photographic method of recording the temperatures, which permits a large number of simultaneous observations. The molecular depression of the temperature of maximum density is about 12 for KCl and RbCl, 13 for NaCl, and 6 for LiCl. The figure for lithium chloride is very remarkable. E. E. F.

1627. *Improved Pyknometer.* **A. Minozzi.** (Roma R. Accad. Lincei Atti, 8. pp. 450–452, 1899.)—The author describes an improved Sprengel pyknometer, which is easily filled



by means of the tubes *d* and *f* (shown in the diagram), and stopped by the caps *c* and *e*, and has the advantage that if the temperature of the bath is too high and the liquid escapes, it ascends into the empty portion *g*. It is specially suitable for hygroscopic and volatile liquids. E. E. F.

1628. *Curvature of Surfaces.* **B. Wanach.** (Zeitschr. Instrumentenk, Beib. 7. p. 50, 1899.)—In the ordinary method of determining curvatures of surfaces by Helmholtz's ophthalmometer or an instrument for measuring angles, it is customary to use an approximate formula obtained by assuming that the angles, sines, and tangents are all equal.

By a transformation of the original formula the author in this paper shows how second and third approximations may be obtained for the radius. J. B. H.

1629. *Artificial Mirages and Tornadoes.* **R. W. Wood.** (Phil. Mag. 47. pp. 349–353, 1899.)—Details of some experiments on the artificial production of mirages. Light was sent through a trough containing layers of liquid of different density, the intermediate layer of liquid having the highest refractive index. A nearly horizontal ray will be bent towards, and will cross, the plane of maximum optical density where it changes its curvature and is again bent towards the plane, which it may cross again and again, traversing a path which is approximately a sine curve. Artificial tornadoes were also obtained by means of precipitated silica sprinkled over a metal plate, which was then heated. These are also well shown when sal-ammoniac is dusted over a heated plate; a miniature tornado of dense smoke two metres high was thus obtained. J. J. S.

1630. *Gravity Balance.* **R. Threlfall** and **J. A. Pollock.** (Roy. Soc. Proc. 65. pp. 123–126, June, 1899.)—Description of a quartz thread gravity balance, probably with a maximum error of 1 in 300,000 in determining the value of g. A. D.

1631. *Production of Waves in an Elastic Solid.* **Kelvin.** (Phil. Mag. 48. pp. 227–236, August, 1899.)—In this, the concluding part (see also 1899, Abstract No. 1120), the author recurs to the case of a rigid sphere of radius g executing harmonic vibrations in an elastic solid. The equations for determining the motion at points in the solid are given, and by the aid of diagrams the gradual transition is shown from the motion $h \sin \omega t$ at the surface of the sphere to that which is found at more distant points. As one of the results obtained, the author rejects his old hypothesis (on the Reflexion and Refraction of Light, Phil. Mag. 1888) of a very small velocity for irrotational wave motion in the undulatory theory of light. S. H. B.

1632. *Deformation of Waves.* **P. Vieille.** (Compt Rendus, 128. pp. 1437–1440, June 12, 1899.)—Intense wav of compression were produced by exploding gunpowder in an iron tube closed at both ends. Traces of the pressure curves at both ends, and also at two intermediate points, were obtained by means of recording manometers. The powder was exploded at one end of the tube. On comparing the pressure curves taken at the different positions in the tube it appeared that the pressure rose more rapidly in the wave front when it had travelled out than near the origin or point of explosion. The curves, in fact, showed a gradual growth in steepness, with the distance approximating towards discontinuity. The velocity of propagation of the disturbance deduced from the curves was also abnormal, about 600 m. per sec., or nearly twice the velocity of sound.

At the intermediate points in the tube the heights of successive crests on the pressure curves, as the compression passed backwards and forwards in the tube, showed that on reflection at the ends the waves were reinforced in intensity in a conspicuous manner. This is attributed to the gas in the tube being given a general movement in the direction of propagation on the passage of these waves, and then to this movement being arrested by the ends of the tube.

In this way also is explained the curious observations of a somewhat similar nature made by Violle and Vauthier at Grenoble. F. T. T.

1633. *Reflection and Refraction of Elastic Waves with Seismological Applications.* **C. G. Knott.** (Phil. Mag. 48. pp. 64–97, July, 1899.)—This paper consists of three parts. Part I. is substantially the author's seismological paper of 1888, first published in the Transactions of a Tokyo Society which is now defunct. Part II. contains detailed calculations for rock-rock and for rock-air interfaces, similar to those for a rock-water interface contained in the first part. Part III. gives the mathematical investigation and the various formulæ used for the calculations. Stress is laid on the fact that an elastic wave of any type incident upon an interface will, in general, break up into *four* parts, two distortional (reflected and refracted) and two condensational-rarefactional (reflected and refracted). E. H. B.

1634. *Seismometrographs.* **A. Cancani.** (Roma R. Accad. Lincei Atti, 8. pp. 447–450, 1899.)—The author disposes of the objections urged by G. Agamennone against the use of continuous-speed seismographs by pointing out that if the records are taken by means of lampblack instead of ink, even the shortest vibrations of the ground, of a period of about 0·1 sec., can be clearly followed by means of a lens, even though the velocity does not exceed 6 m. per hour. The other objection, viz., that owing to the proximity of the traces they must be confounded as soon as they are of considerable amplitude, can be met by displacing the slide in a direction normal to the trace as soon as a considerable tremor is announced. E. E. F.

1635. *Microseismograph.* **T. Gnesotto.** (N. Cimento, 9. pp. 454–461, June, 1899.)—The author gives a detailed description of Vicentini's microseismograph with two components as used for the study of the slow movements of the soil, and also instructions for its use. E. E. F.

1636. *Measurement of an Arc of the Meridian.* **Bassot.** (Paris, Soc. Franc. Phys. Bull. 134. pp. 2–3, June, 1899.)—The British, French, and Spanish triangulations cover an arc of nearly 30°, if the French Soudan is included. The arc should, however, be measured under very different latitudes. Russia and Sweden are measuring an arc of 4° or 5° which is more northern than that of Lapland already measured. The Congo basin is not suitable for such measurements, as the landscape offers few points suitable for signal stations. Arrangements are being made for measurements in Ecuador. E. E. F.

1637. *Barometric Determination of Height.* **L. Papanti.** (N. Cimento, 9. pp. 465–469, June, 1899.)—The author simplifies the usual formula for barometric hypsometry by introducing the absolute temperature θ, and obtains

$$A = sq\,\theta\,\frac{P-p}{P+p}$$

He also investigates the influence of temperature generally in the determination of heights by the barometer. E. E. F.

1638. *Atmospheric Tides.* **F. Morano.** (Roma R. Accad. Lincei Atti, 8. pp. 521–528, June, 1899.)—From observations given by a Richard's self-registering barometer at Rome during the years 1891, 1892, 1893, 1894, the author calculates the average variations of the pressure in the course of a lunar day. He concludes: 1. The barometric variation in the lunar day indicates a double oscillation. The two maxima occur about the time of the two culminations; the two minima near the rising and setting of the moon. 2. The amplitude of the oscillation is 0·053 mm.

Assuming the height of the earth's atmosphere to be 300 kilometres, he calculates that the moon produces a tide 21 metres, the sun a tide 10 metres, high. The maximum tide is thus 31 metres. A. Gs.

1639. *Height of Clouds.* **A. Sprung.** (Zeitschr. Instrumentenk. 19. pp. 111–118 and 129–137, 1899.)—This paper gives a description of the automatic photographic apparatus erected at Potsdam for the measurement of the height of clouds on the zenith by simultaneous photography from two stations. The determination of the zenith errors of each instrument by photography of the path of a star is given *in extenso*. The other possible errors are also discussed. J. B. H.

1640. *Lunar Influence on Barometric Charts.* **A. Poincaré.** (Comptes Rendus, 129. pp. 128–131, July 10, 1899.)—Barometric charts have been taken every day throughout several synodic periods, and the results of two of them (March and October, 1883) are plotted as curves to illustrate the relation on the change of barometric pressure with the distance of the moon from the meridian, as shown at varying latitudes on the earth's surface. C. P. B.

1641. *Periodicity in the Weather.* **H. H. Clayton.** (Amer. Acad. Proc. 34. pp. 599–618, 1899.)—The author reviews the various theories on periodicity in the weather with special regard to the influence of the moon and its declination on air pressure, temperature, thunderstorms, auroral frequency, &c. He himself accepts such influences, and assumes that every weather period is rendered complex by the existence of periods which bear the relation of harmonics to the primary, *i.e.*, their length is twice, one-half, one-third, &c., of the length of the primary. Thus he discusses periods of two years, thirty or twenty-nine days, seven days, three and a half days. His temperature curves are not as a rule synchronous with the time curves, but lag behind or lead; the transition he calls a reversal. His own arguments refer to observations made in the United States; the first part of the paper is based upon observations conducted in other countries. H. B.

1642. *Meteorological Registration by Kites.* **L. T. de Bort.** (Comptes Rendus, 129. pp. 131–132, July 10, 1899.)—The utilisation of kites for carrying self-recording meteorological instruments to various heights in the atmosphere was first successfully applied in the United States, and for the last four years L. Rotch has obtained valuable and interesting documents in this way at the Blue Hill Observatory near Boston.

The author's observations commenced in 1897, and in 1898 his apparatus reached a height of 2,000 metres, while this year (1899), in consequence of the use of kites of the Hargrave cellular pattern, they have been able to work at an altitude of from 3,940 to 3,590 metres. They find that the law of decrease of temperature with increase of altitude is different according as the area investigated is one of low or of high pressure; also that in clear weather with high pressure the velocity of the wind decreases with the height, whereas in cloudy weather with low pressure the wind velocity increases at higher altitudes. C. P. B.

1643. *Interference Applied to Metrology.* **A. Perot** and **C. Fabry**. (Astro. Phys. Journ. 9. pp. 87–115, 1899.)—The paper is a translation from the original article in Bull. Astron. 16, 5, January, 1899, and describes the author's now well-known methods of measuring lengths and thicknesses by observing the interference fringes produced between silvered surfaces. C. P. B.

1644. *Temperature and Vapour Gradients in the Atmosphere.* **F. H. Bigelow.** (Amer. Assoc. Proc. 47. pp. 127–129, 1898.)—A discussion of the various formulæ expressing the thermodynamic conditions of the atmosphere. These formulæ are of two types, the exponential and the logarithmic. J. J. S.

1645. *Movement of Terrestrial Pole.* **E. F. Van de Sande Bakhuyzen**. (Archives Néerlandaises, 2. 5. pp. 447–486, 1899.)—The author summarises all the available researches on the question and gives tabular comparisons of the various results obtained by Chandler, Albrecht, and others, showing the present state of the subject. C. P. B.

1646. *The "Green Ray" after a Red Sunset.* **Guébhard.** (Paris, Soc. Franc. Phys. Bull. 131. pp. 5–6, 1899.)—The green ray seen after a red sunset is not subjective, but is the grey shadow of the earth, feebly illuminated from the zenith and viewed by an eye fatigued for red; it therefore appears green. **M. Pellat** says the phenomenon is more distinct; the setting yellow sun has a red lower and a green upper border, separately examinable in the telescope, and due to prismatic refraction by the atmosphere. The absorption which makes the sun's disc appear yellow makes the violet upper rim appear green or greenish blue instead of violet. When the sun sets the upper green rim can be seen for a fraction of a second, but can be kept longer in view if the observer go up a slope as the sun sets. **M. Guébhard** thought this was different from the green ray following the setting of a *red* sun. **M. Raveau** had seen the sea coloured green in a triangle with its apex at the point where the sun set; and the colour seems to flow away towards the horizon. A. D.

1647. *Stellar Radial Velocities.* **F. Schlesinger.** (Astro. Phys. Journ. 9. pp. 159–161, 1899.)—Spectroscopic determinations of velocity in the line of sight are usually given with respect to the sun, but of course the original observation gives the velocity relative to the earth, and for the necessary reduction somewhat lengthy computations have to be effected. To partly minimise this labour, the author has tabulated the corrections to be applied for the different positions of the earth throughout the year, so that any observations may be reduced to the sun without the usual calculations. C. P. B.

1648. *Determination of Stellar Radial Velocities.* **H. Deslandres.** (Astro. Phys. Journ. 9. pp. 167–172, 1899.)—The paper is a reply to a criticism made by Vogel, of Potsdam, on a former paper of the present author. In this article more details are given as to the methods of eliminating errors in the photographic method of determining the velocities of stars in the line of sight. The writer finds the variation of temperature during, say, an exposure of one hour, to be distinctly appreciable, and proposes several methods for attempting to maintain a constant temperature of the spectrograph. The main effect is that the index of refraction of the prisms is changed, this of course manifesting itself in a variation of the dispersion. Electric heating and a continuous circulation around the apparatus have been tried with partial success, and the suggestion is made that a spectrograph specially built of Guillaume's ferro-nickel alloy, with the prisms of zinc crown (this material not suffering a change of refraction with variation of temperature), might be a great improvement on present designs. C. P. B.

1649. *Typical Spectra of New Stars.* **J. Wilsing.** (Berlin Akad. Sitzber. 24. pp. 426–436, 1899). The most striking particular in the spectrum of Nova Aurigæ (1892) was the occurrence of pairs of lines, each consisting of a *bright* line accompanied by an *absorption* line on its more refrangible (violet) edge. The first explanation put forward to account for this was an application of Doppler's principle, the consideration of which necessitated the presence of two aggregations of matter having different velocities in the line of sight, so that the spectrum lines of each were relatively displaced, producing the doubling. Plausible at first, this view presented the difficulty that the displacements of the lines indicated relative velocities of from 1,000 to 1,500 kilometres per second. This fact, together with the observation that no change in the relative positions of the lines occurred for several months led to this simple explanation being doubted.

Other conditions, not involving motion of the light sources, are known to influence wave-length, viz., fluorescence, super position of different masses of gases at varying temperatures, and varying pressure. In the latter case, the displacement is always towards the red with increasing pressure.

Recent work by Ebert and Gouy has shown that displacements occur with variations in the density of the vapour producing the light.

In view of these facts the author was led to experiment with spark discharges in liquids which were known to produce very high tensions, as it was impracticable to actually increase the pressure to the extent which would be necessary to give displacements as large as those found in the spectrum of Nova Aurigæ.

The spectrum obtained was 50 mm. in length from λ 4800 to λ 4600, so that considerable accuracy was possible. Photographs of the spectra of iron, nickel, platinum, copper, tin, zinc, cadmium, lead and silver in water were obtained; and comparisons with the spark taken as usual in air, showing that many of the bright lines suffered a considerable displacement towards the *red* under the new conditions. No difference could be detected in the behaviour of water and alcohol. As found by Humphrey and Mohler (Astr. Phys. Jour. 3. p. 135, 1896), the displacements are greater in the spectra of cadmium, zinc and tin, than in the case of iron and platinum.

In addition several sets of double lines appear. These facts and the laboratory experiment showing that the lines of hydrogen from a vacuum tube broaden as the pressure is increased would indicate a possible bearing on the constitution of new stars.

C. P. B.

1650. *Oxygen in Stellar Atmospheres.* **D. Gill.** (Roy. Soc. Proc. 65. pp. 196–206, July, 1899.)—The possibility of certain lines in the spectra of β Scorpii, β Canis Majoris, β Centauri, and β Crucis being due to oxygen was first suggested by F. McClean in 1897, from the evidence afforded by photographs he obtained with his prismatic camera. Since that time he has presented to the Cape Observatory a complete astrophysical equipment, including a 24-inch photographic refractor with objective prism and a powerful slit spectroscope. The present paper is the result of the first series of investigations made with the new instrument. After describing in detail the slit spectroscope, which weighs 400 lb., the author gives some explanation of the methods of interpolation for reduction of the plates, followed by tables of the measured lines in the spectrum of β Crucis, showing the probable coincidences with oxygen. The region of spectrum investigated extends from λ 4187·99 – λ 4563·99, the length of which on the plate is 70·367 mm. Photographs of the spectra of β Crucis and ε Canis Majoris are sent with the article. C. P. B.

LIGHT.

1651. *Characteristics of Crystals.* **C. Leiss.** (Berlin Akad. Sitzber. 3. pp. 42–47, 1899.)—A description is given of a method for obtaining photographic pictures of the section curves of the wave surfaces of crystals. J. J. S.

1652. *Optical Constants of a Crystal.* **C. Viola.** (Roma R. Accad. Lincei Atti, 8. pp. 276–281, 1899.)—Method described whereby, taking directions of plane of polarisation into account, the three indices α, β and γ, the three angles A, B and C, and the angle of the optic axes can be ascertained from any one section of a crystal taken at random. A. D.

1653. *Water Optically Uniform.* **A. Battelli** and **M. Pandolfi.** (N. Cimento, 9. pp. 321–326, 1899.)—Water, quite pure, is not illuminated by a beam of light, and water can be rendered non-illuminable by distilling it in vacuo or by causing the production of a gelatinous precipitate in it. Pure ethylic and amylic alcohol are not illuminated. Air dissolved in water does not appear to be among the causes which render it capable of shining in the track of a beam of light. A. D.

1654. *Reflection at Mercury Surfaces.* **H. Wallbott.** (Wied. Annalen, 68. 3. pp. 471–495, July, 1899).—When mercury is covered with freshly split mica, pure collodium, or well-dried gelatine, only a very slight discrepancy remains between the observed change of phase in the reflected light and its theoretical value. For mica, the following phase accelerations are obtained for the four chief Fraunhofer lines :—

	C	D	E	F
λ	656	589	527	486
ϕ	0·417	0·413	0·405	0·395

The metallo-optical theory for the change of phase at the surface of thick layers of mercury may therefore be regarded as confirmed. The deviations from the theoretical value observed when the covering substance is not quite pure are due to the formation of foreign surface films between the mercury and the cover. As the purity of the covers is gradually increased, the deviations approach vanishing point. The disturbing films produce a greater dispersion of the phase retardations, the latter being increased in the red and reduced in the violet. E. E. F.

1655. *Transmission of Light through an Atmosphere containing Small Particles in Suspension.* **Rayleigh.** (Phil. Mag. 47. pp. 375–384, 1899.)—A mathematical investigation into the attenuation undergone by the primary light on its passage through a medium containing small particles, as dependent upon the number and size of the particles. Regarding the interesting connected question whether the light from the sky can be explained by diffraction from the molecules of air themselves, or whether it is necessary to appeal to suspended particles composed of foreign matter, solid or liquid, the author concludes that even in the absence of foreign particles, the light scattered from the molecules of air would suffice to give us a blue sky, not so very much darker than that actually enjoyed. J. J. S.

1656. *Aberration in Astronomical Telescopes.* **H. Harting.** (Zeitschr. Instrumentenk. 19. pp. 138–143, 1899.)—The author here investigates whether it is possible by suitably choosing the glasses in the two lenses of an astronomical telescope objective, so to arrange the two focal surfaces that they shall be symmetrical with respect to the plane perpendicular to the axis through the principal focus.

He starts with Airy's equations for the curvature of these surfaces where they cut the axis—

$$\gamma_s = 1 + \Sigma\frac{\phi}{n} \text{ and } \gamma_t = 3 + \Sigma\frac{\phi}{n}$$

where $\phi = \frac{1}{f}$ (f being measured in terms of the focal length of the objective, it being taken as unity), and n is the refractive index.

The condition for symmetry is $\gamma_s = -\gamma_t = -1$, and the conditions to be satisfied by the lens are therefore—

$$\Sigma\frac{\phi}{n} = -2$$

$$\Sigma\phi = 1$$

and the condition for achromatism—

$$\Sigma\frac{\phi}{\nu} = 0$$

where ν is the reciprocal of the dispersive power.

Letting $\lambda = \frac{\nu_1 - \nu_2}{\nu_1}$ the author uses n_1, n_2, and λ as his three variables, and taking values of $1/\lambda = 30$, 12, 6, 4, 3, and 2, he calculates for each of these the values of $\Sigma\frac{\phi}{n}$ corresponding to the thirty-six different combinations obtained by giving six different values (between 1·50 and 1·65) to n_1 and n_2. There are thus six tables each corresponding to one value of $1/\lambda$, and in each table are six columns of six numbers each. The author has marked those numbers to which he could find glass to correspond in Messrs. Schott and Gen's catalogue.

None of these values, however, make $\gamma_s = -\gamma_t = -1$. The smallest value of $\Sigma\frac{\phi}{n}$ to which glasses correspond is $-0{\cdot}466$ when $1/\lambda = 30$, while the value of $\Sigma\frac{\phi}{n}$ in an ordinary flint-crown combination is $+0{\cdot}762$ when $1/\lambda = 3$. High values of $1/\lambda$ give, however, very low values of $\nu_1 - \nu_2$ (from 0·67 to 2·33 for $1/\lambda = 30$), but even in objectives which require only a small aperture (*e.g.*, those used to photograph the sun), this ν difference must not be less than about eight or ten, so a further limitation is added to the possible flattening of the field. It is, therefore, only possible to make a very slight improvement in the flatness of the field in an astronomical telescope by specially choosing the kinds of glass for the lenses; and this advantage only accrues in the case of projection or of photography, as, immediately an eyepiece is introduced, the aberration in it makes the improvement entirely nugatory. J. B. H.

1657. *Large Speculum.* **P. Gautier.** (Comptes Rendus, 128. pp. 1373–1375, June 5, 1899.)—A description of the manufacture and tests of the speculum referred to in Abstract No. 1131 (1899). C. P. B.

1658. *Oscillating Focometer.* **C. Dévé.** (Comptes Rendus, 128. pp. 1561–1564, June 26, 1899.)—This instrument serves to measure the curvatures, focal lengths, and aberrations of optical surfaces. The optical system producing the image observed is so arranged that it can oscillate about an axis near the image. If the image is observed with the aid of an eyepiece and cross-wires, it follows the oscillations of the apparatus unless it is exactly on the axis of oscillation. If the image passes above or below the axis, its oscillation changes in sense with regard to the oscillation of the apparatus. It is therefore easy to find at once in what sense the image must be displaced to bring it to the level of the axis. When the image appears fixed, the distance of the axis from the optical surface is measured. The precision obtained is much greater than that obtained by the ordinary methods, as may be shown by adjusting the image until no parallax can be detected. There is then, as a rule, some slight residual motion on rotating the apparatus. Only a very small portion of the optical surface need be used at a time, and thus the curvatures of the different portions of the same surface may be compared.

E. E. F.

1659. *Self-Correcting Photometer.* **B. Speed.** (Elect. World and Engineer, 33. p. 873, June 24, 1899.)—A slide rule scale is so applied to a standard glow lamp photometer that corrections for fractional candle-power in the standard can be read off rapidly. M. O'G.

1660. *Photometer.* **J. Hartmann.** (Zeitschr. Instrumentenk. 19. pp. 97–103, 1899.)—This instrument is designed to compare the relative brilliancies of, say, different parts of the moon's surface or of the surfaces of comets, or generally to compare the brilliancies of any two surfaces. The method is a photographic one, the instrument being used to compare the depth of tint at any point on the photographic plate with that on a standard plate; the point on the standard plate which has the same depth of tint being noted. The standard plate has on it a band, the tint of which gradually deepens from one end towards the other, and is provided with a scale along the band. This scale could be graduated by experiment in candle-power corresponding to one definite time of exposure.

The photometer is of the Lummer-Brodhun type, a small ellipse being silvered on the hypotenuse of one of the two prisms before the two are put together. In order to work on very small portions of the plates, microscopic objectives are introduced in the two beams. These form magnified images of the films at the prisms and these images are then examined through an eyepiece. Arrangements are provided for illuminating equally the two plates under comparison. J. B. H.

1661. *Actino Photometer.* **C. Henry.** (Comptes Rendus, 128. pp. 941–943, 1899.)—A good photographic actinometer should measure all the radiations which reduce silver gelatino-bromide, and its indications should strictly correspond with the behaviour of the sensitive plate. These conditions are well fulfilled by the author's phosphorescent zinc sulphide. The most remarkable analogy exhibited is that between halation and the reversing effect of very strong exposures on the luminosity of the sulphide. The author has constructed an actinometer consisting of a series of semi-translucent and semi-phosphorescent screens; after exposure to the source the screen is placed at the end of a tube, and its luminosity compared with that of a screen of ground glass illuminated by a standard candle. Knowing the rate at which the sulphide loses its luminosity, it is easy to determine its original luminosity, acquired under the influence of a source. Measurements with this actinometer show that a solution of alum transmits more actinic rays than a solution of carbon bisulphide. If the intensity of illumination of the two screens of a Foucault photometer is equalised, and a saturated sulphide screen is placed before each, and behind a bichromate vessel, a very rapid means is obtained for determining the relative value of two sources of light by differences of extinction. E. E. F.

1662. *Amyl Acetate Standard Lamp.* **W. M. Stine.** (Amer. Electn. 11. pp. 208–210, 1899.)—This paper gives a full description of the Hefner-Alteneck standard lamp, and the precautions to be taken in its use. The most important of them is to have the flame at exactly its proper height of 40 mm., as the rate at which the illuminating power increases is 2·5 per cent. for every millimeter above 40, and 3 per cent. decrease for every millimeter below 40. Another correction that is necessary for accuracy is that due to humidity of the air, as a possible error of 8·5 per cent. may exist due to this cause. E. C. R.

1663. *Colour-Weakness and Colour-Blindness.* **E. W. Scripture.** (Science, 9. pp. 771–774, June 2, 1899.)—The author condemns the ordinary wool and card tests for colour-blindness, and emphasises the importance of being able to name the colour. The following cases are given as examples: 1. A person whose eyes were abnormally acute for differences in colour, who could match wools at any distance, but yet who had only two fundamental sensations instead of three. 2. Persons who possess perfect colour vision for near objects or bright objects, but who are practically colour-blind for weakly illuminated or distant objects. Such persons will pass the wool test when performed near at hand. These persons possess the three fundamental colour sensations, but have one of them weaker than the normal.

The author has invented a "colour sight tester" of a different kind. It consists of two concentric discs, one fixed to a handle and having three circular windows in it, one containing ground glass, the second lightly smoked glass, and the third thickly smoked glass. The second disc can rotate on its axis, and has twelve coloured glass windows in it, any one of which can be made to appear behind any one of the three grey windows in the other disc. The colours are mostly greens, greys, and reds, and the appearances as seen through the three different windows give direct simultaneous comparisons of reds, greens, and greys of different shades. J. B. H.

1664. *Diffraction Colour-Photographs.* **R. W. Wood.** (Phil. Mag. 47. pp. 368–372, 1899.)—If a diffraction-grating of moderate dispersion and a lens be placed in the path of a beam of light coming from a linear source, and the eye be placed in any one of the spectra formed to the right and left of the central image, the entire surface of the grating will appear illuminated with light of a colour depending on the part of the spectrum in which the eye is placed. If one part of the grating has a different spacing from the rest, the spectrum formed by this part will be displaced relatively to the first, and if the eye be placed in the overlapping part of the two spectra, the corresponding portions of the grating will appear illuminated in different colours. This principle has been made use of by the author in the development of a new method for producing photographs in natural colour. The use of pigments and coloured screens is eliminated in the finished picture, the photograph being simply a diffraction-grating of variable spacing, the width between the lines in the different parts of the picture being such as to cause them to appear illuminated in their proper colours when viewed as described. Details of the manipulation are given. The apparatus for viewing the pictures consists of a cheap double-convex lens mounted on a small frame with a perforated screen for bringing the eye into the right position. The author considers that by the use of a suitable photographic plate to be exposed in succession in the camera, under red, green, and blue screens, on the surfaces of which suitable diffraction-gratings have been photographed, it will be possible to obtain the colour-photograph directly. J. J. S.

1665. *Equations of a Plane Electromagnetic Wave.* **E. B. Rosa.** (Phys. Rev. 8. pp. 282–296, 1899.)—The author shows briefly the formation of the differential equations by which light as an electromagnetic phenomenon is characterised. The student, he says, is apt to wonder how so much information can be extracted from differential equations, although perhaps a differential equation is the necessary form in which the result of observations is expressed. Having explained the derivation of the ordinary equations, he makes the assumption that we have a wave of electric force travelling along the axis of x, the force varying as the sine of an angle. From this assumption he explains by the aid of diagrams from general considerations the properties of such a wave. S. H. B.

1666. *Diffraction Fringes Applied to Micrometric Observations.* **L. N. G. Filon.** (Phil. Mag. 47. pp. 441–461, 1899.)—This paper is a criticism and extension of a previous paper by A. A. Michelson, "On the Application of Interference Methods to Astronomical Observations." The author first deduces a general expression for the intensity of the illumination at any point of the diffraction pattern formed by a lens on a screen when light from a point source is transmitted through two equal and parallel slits in an opaque membrane, each of a definite length and width. The case of two point sources is then considered, and the modifications produced by the overlapping of their diffraction patterns are noticed.

It may be observed that, when two diffraction patterns arising from two distinct sources overlap, it is not unfrequently assumed that the intensity at any point of the overlapping region is equal to the sum of the intensities which each source separately produces at that point. This is true in a particular case, viz., when the phases of the two vibrations produced by the two sources at the point in question differ by 90°. Under all other circumstances the phase difference δ must be taken into account, and the resultant intensity is not I_1+I_2, but $I_1+I_2+2\sqrt{I_1I_2}\cos\delta$.

The theory is next applied to the case of an extended source, and a general expression is obtained for the intensity at any point of the diffraction pattern. If $2h$ be the length of either slit, the three cases which present themselves and which are considered in detail are:—

1. When the angular dimensions of the source are large compared with λ/h.
2. When the angular dimensions of the source are small compared with λ/h.
3. When the angular dimensions of the source are neither large nor small compared with λ/h.

The final conclusions arrived at are that:—

1. It is possible by the observation of Michelson's interference-fringes to separate a double point source, or detect breadth and ellipticity in a slightly extended source.
2. But the distance between the two points, or the dimensions of the extended source, must be within certain limits, depending on the length and breadth of the slits.
3. The dimensions of the slits also considerably affect the general theory, the formula obtained not being identical with Michelson's. The law of appearance and disappearance of the fringes depends very largely on the distance between the points or the dimensions of the extended source. T. P.

1667. *Velocity of Light in a Magnetic Field.* **E. W. Morley, H. T. Eddy, and D. C. Miller.** (Amer. Assoc. Proc. 47. pp. 123–124, 1898.)—As the result of their experiments the authors report that when light corresponding to the solar D line passes through 120 cm. of carbon bisulphide in a magnetic field sufficient to produce rotation of the plane of polarisation by half a circumference, there is no such change of velocity as one part in sixty million, probably not one part in one hundred million.

J. J. S.

1668. *Vibrations of Charged Ions in a Magnetic Field.* **H. A. Lorentz.** (Archives Néerlandaises, 2. 5. pp. 412–434, 1899.)—This is a mathematical paper by which on certain hypotheses the presence of a number of rays is predicted and their frequencies and intensities calculated. On *observing perpendicularly* to the lines of force, the following rays are accounted for: A. Rays whose *vibrations* are *parallel* to the lines of force—a median ray and two outside rays. B. Rays whose *vibrations* are *perpendicular* to the lines of force—six rays, being two of each of three classes. On *observing along* the lines of force the same rays are obtained as in case B, and of the same relative intensities, but they are now *circularly polarised*. E. H. B.

1669. *Zeeman Effect and Theory of Lorentz.* **H. Poincaré.** (Écl. Electr. 19. pp. 5–15, 1899.)—This is a general exposition of the theoretical explanation advanced by Lorentz to account for the radiation phenomena in a magnetic field—known as the Zeeman effect. When it was found by experiment that different spectral lines behaved in different ways in the magnetic field, some being resolved into quartets, sextets, octets, or other complex forms, it became evident that the simple theory, which indicated tripling only for all the spectral lines, required modification and extension. This extension was introduced by Lorentz in the shape of an hypothesis concerning the ions. The simple theory supposed the ions to be simple electrified particles, and the further extension assumes them to be complex dynamical systems. This new supposition leads to equations of a more complex character, which appear to explain some at least of the more complex results obtained by experiment. T. P.

1670. *Effect of Medium upon Wave Form of Light.* **W. Voigt.** (Wied. Annalen, 68. 3. pp. 598–603, July, 1899.)—In a medium in which the propagation of plane waves is governed by the equation

$$\frac{\delta^2 u}{\delta t^2} = a^2 \frac{\delta^2 u}{\delta z^2}$$

all vibrations are propagated with unaltered phase. But that equation is the only one possessing that property, and it only applies to a vacuum, or to the propagation of purely periodic vibrations. The author shows that ordinary light does not by any means consist of such vibrations, and that monochromatic light, propagated through a dispersing or absorbing medium, must, after emergence, be accompanied to a slight extent by light of all other wave-lengths. E. E. F.

1671. *Broadening and Reversal of Spectrum Lines.* **W. Voigt.** (Wied. Annalen, 68. 3. pp. 604–606, July, 1899.)—The broadening of the D lines observed by Wanner (see 1899

Abstract No. 1347) is partly explained by the reasoning in the preceding paper, and partly by the effect of the simultaneous action of independent volume elements of the flame, dealt with by the author in a former paper. Reflection at the surface of an absorbing body must produce the same effect as absorption by the same body, since the reflected wave is connected with the refracted wave by the terminal conditions. E. E. F.

1672. *Sellmeier's Theory.* **Kelvin.** (Phil. Mag. 47. pp. 302–308, 1899. Read before the Royal Society of Edinburgh on February 6, 1899.)—A discussion of the application of Sellmeier's dynamical theory to the dark lines D_1, D_2 produced by sodium-vapour. A definite mechanical representation of Sellmeier's theory is given, and Becquerel's recent experiments showing anomalous dispersion by prisms of sodium-vapour are referred to. In Becquerel's photographs the characteristic nullity of absorption and finite breadth of dark lines, originally shown in Sellmeier's formula of 1872, are exhibited for the first time. The author gives various graphical illustrations of the results of Sellmeier's theory based on the experimental case of sodium-vapour.

J. J. S.

1673. *Determination of Reference Lines in Spectra.* **M. Hamy.** (Comptes Rendus, 128. pp. 1380–1382, June 5, 1899.)—Until a few years ago physicists were dependent on diffraction gratings for the absolute determination of the wave-lengths of the lines in discontinuous spectra, but the work of A. A. Michelson on luminous sources of sufficient simplicity to give interference under very great retardation has rendered possible a much more critical determination of these important constants.

The author proceeds to describe the method he is following for measuring the wave-lengths of standard lines throughout the spectrum by the use of interference fringes. To enable him to do this he has designed what he calls a "simplifier" (see Comptes Rendus, 125, p. 1092, 1897), with which he can suppress one or more members of a doublet or a triplet without appreciably reducing the intensity of the remaining light. He has used interference fringes of two types:—

1. Newton's rings from light almost parallel at normal incidence. These are obtained by passing the light through a semicircle of small diameter fixed at the focus of a collinator, the lens of which has its outer face thinly silvered, this being placed near to a small plane silvered mirror, which reflects the image of the semicircle back again to the focus of the lens. The fringes thus produced, he says, are very sharp, and are visible with as great a retardation as 10 cm. The measures of wave-length are independent of the diameter of the aperture and the focus of the lens.

2. The fringes localised at the focus of a plano-convex lens, the plane surface of which is half-silvered and placed parallel to a plane mirror totally silvered.

The source of light preferred is that given by vacuum tubes excited by an induction coil (using 3–4 amperes at 10 volts) both with and without a condenser in parallel on the secondary circuit.
C. P. B.

1674. *Dispersion: Luminous and Electric.* **L. Barbillion.** (Écl. Electr. 19. pp. 246–252, 1899.)—The author discusses the various theories of optical dispersion put forward by Cauchy, Kelvin, Helmholtz, and others, and seeks a single expression which shall embrace, in accord with experiments, both luminous and electric waves.
E. H. B.

1675. *Absorption Spectrum of Benzene.* **W. N. Hartley** and **J. J. Dobbie.** (Journ. Chem. Soc. 73. pp. 695–697, 1898.)—A description of the spectrum of benzene, the measurements having been taken from solutions of benzene in alcohol. Strong absorption bands to the number of six were observed. The absorption bands are sharpest where the rays are of shorter wave-length, and are gradually weakened in the opposite direction, as if they were groups of lines closer together and stronger on the side where the rays are of smallest wave-length.
J. J. S.

1676. *Simple Apparatus for Spectroscopic Photography.* **J. H. White.** (Scientific American, 80. p. 43, 1899.)—An account of results obtained with a small pocket spectroscope and camera. With fifteen seconds exposure a picture of the solar spectrum three inches long with abundance of lines was obtained.
J. J. S.

1677. *Spectroscope with Variable Scale.* **A. de Gramont.** (Comptes Rendus, 128. pp. 1564–1568, June 26, 1899).—To reduce a spectrum observed in an ordinary spectroscope to any desired micrometric scale, the author constructs a spectroscope in which the micrometer is mounted in an extra collimator, and its image is reflected into the telescope by a face of the prism. An arrangement of two lenses in the extra tube permits the observer to enlarge or reduce the micrometer scale. By rotating the prism out of the position of minimum deviation, the author is also enabled to change the dispersion of the prism in any given region. These two adjustments facilitate the mapping of an unknown spectrum in terms of a known one.
E. E. F.

1678. *Echelon Spectroscope.* **A. A. Michelson.** (Journ. de Physique, 8. pp. 305–314, June, 1899.)—The chief portion of the paper consists of a detailed description of the principle and theory of the echelon, which has already been previously published (see 1898, Abstract No. 1118). The mathematical portion of the theory is, however, somewhat more complete in the present article. Following this the author describes experiments he has been making in the endeavour to overcome the difficulties involved in using a "reflection echelon," the principle of which is that the several plates are separated by minutely different thicknesses of air, the effect of which on the resolution of the spectra is *six* times as great when the instrument is used by reflection as when it is used by transmission.

C. P. B.

1679. *Charge Carried by Röntgen Ions.* **J. J. Thomson.** (Phil. Mag. 46. pp. 528–545, 1898.)—In a gas exposed to Röntgen rays and acted upon by a known electromotive force, measurement of the current passing gives the value of nev, where n is the number of ions in unit volume of the gas, e is the charge on an ion, and v is the mean velocity of the positive and negative ions under the electromotive force to which they are exposed. The object is to find e. Rutherford (Phil. Mag. 44. p. 422, 1897) has given values of v: it remains to find n. The method used depends on the discovery of C. T. R. Wilson (Phil. Trans. A. 1898, p. 265) that when Röntgen rays pass through dust-free air a cloud is produced by an adiabatic expansion which is incapable of producing cloudy condensation when the gas is not exposed to these rays. The ions caused by the Röntgen rays seem to act as nuclei, round which the water condenses. If we knew the size of the drop and the mass of water deposited we would know the number of drops and therefore the value of n. Measurement of the size of the drops by optical means proved inapplicable, and the method finally adopted was to apply the formula for v, the rate at which the cloud sank; $v = 2ga^2/9\mu$, where a is the radius of the drop, μ the coefficient of viscosity of the gas through which the drops fall, and g the value of gravity. It was established that the ions do act as nuclei: if the ions be removed by exposing the expanding air to a strong electric field, no cloud is formed. But the ions are not all carried down by the cloud; some remain, modified and apparently heavier or more complex, which induce secondary cloud condensation when the expansion is repeated. With sufficiently weak Röntgen rays this complication is absent. The number of ions brought down by a larger expansion (within the limits of 1·25 and 1·40 times the original volume of the gas) is slightly greater than with a smaller one: and it seems probable that positive and negative ions have unequal powers of acting as nuclei, a circumstance which would account for the charging of clouds and the production of atmospheric electric fields, the work required for the production of the field being done by gravity as the charged cloud sinks. The amount of water deposited was computed from thermodynamic and hygrometric data: and the volume and corresponding mass of each droplet were computed from the radius as shown by the rate of fall of the cloud: whence n is of the order 4×10^4 in unexpanded gas. This being ascertained, e is then found to be about $6{\cdot}3 \times 10^{-10}$. Correction for a certain number of nuclei, present in any case and not produced by Röntgen rays, brings this to about $7{\cdot}4 \times 10^{-10}$: and the mean of a series of experiments gives the value $7{\cdot}3 \times 10^{-10}$. But a further correction has to be made for escape of current along the dampish sides of the vessel; this is found to bring the mean result down to $e = 6{\cdot}5 \times 10^{-10}$, for air. For hydrogen, the charge on the ions seems, on the whole, to be the same as in air. In the preceding it is assumed that the potential gradient is constant between the plates, and that all the ions produced are brought down by the cloud; with the weak rays experimented on, the result would be much the same as regards the former of these, but would have to be diminished if any ions were left behind. In any case, electrolytic data give $Ne = 129 \times 10^8$ where N is the number of molecules in 1 cub. cm., and e the charge of each molecule of hydrogen (in E.-S. units); the value $e = 6{\cdot}5 \times 10^{-10}$ would make $N = 20 \times 10^{18}$, whereas under the kinetic theory of gases, experiments on the viscosity of gases give the value $N = 21 \times 10^{18}$. The value given is therefore consistent with the charge carried by the ion produced by Röntgen rays being equal to or of the same order as the charge carried by the hydrogen ion in electrolysis. A. D.

1680. *Triboluminescence.* **W. J. Pope.** (Nature, 59. pp. 618–619, 1899.)—A note on the emission of light not due to rise of temperature which occurs on crushing fresh crystals (from solution in acetone) of commercial saccharin (ortho-benzoic-sulphinide); and also some references to the literature of the subject. A. D.

1681. *Colson-Russell Photographic Effect.* **J. H. Vincent.** (Chem. News, 79. pp. 302–303, June, 1899.)—The paper shows that certain bodies such as indiarubber and camphor, which have been proved by Russell to be quite inactive on a photographic plate in their ordinary condition, become highly active when treated with small quantities of ozone. If a stream of ozonised air be passed through a box containing a sensitive plate below a sheet of indiarubber, the plate will, after five minutes' exposure, give a dark negative image after development, of any opaque body placed between it and the indiarubber. The indiarubber remains active for some days after once ozonising, and, if washed with water, this becomes exceedingly active. A plate, after being subjected to the influence of the ozonised rubber, will before development produce a transfer image on a second plate put in contact with it. The opacity or transparency of different bodies is found to be the same for the active agent from ozonised rubber as for that in the Russell effect. The author attributes the effect to the formation of hydrogen peroxide, as does Russell for his photographs. The water used for washing ozonised rubber gave the tests for hydrogen peroxide. G. H. BA.

1682. *New Radio-Active Substance.* **E. de Haen.** (Wied. Annalen, 68. 4. p. 902, August, 1899.)—By extraction from a large quantity of uranium ore, the author has obtained substances which possess the properties ascribed by M. and Madame Curie to "radium" in an extraordinary degree. Two preparations have been made. Preparation A exhibits the properties of Becquerel rays. It excites fluorescence in a barium platinocyanide screen even across opaque substances, affects the photographic plate, makes air electrically conducting, and has an additional property not hitherto described, that of being itself strongly luminous. Preparation B possesses in general the same properties as preparation A, but the excitement of the screen is more intense, whereas the self-luminosity is feebler. In both cases the rays which produce fluorescence penetrate bodies like black cardboard more readily than they penetrate glass. Both preparations must be carefully preserved from moisture, especially the first preparation, which loses its own luminosity in a few hours when exposed to the moisture of the atmosphere. Once the luminosity is lost it is difficult to restore it. The only expedient which succeeds as a rule is that of melting the substance in the oxy-hydrogen blowpipe. E. E. F.

1683. *Luminosity of the Rare Earths.* **A. A. C. Swinton.** (Roy. Soc. Proc. 65. pp. 115–119, June, 1899.)—The Welsbach incandescent gas mantle contains 99 per cent. thoria and 1 per cent. ceria. This gives eleven times as much light as pure thoria. Acting upon the earths with kathode rays in a vacuum tube, they were brought up to incandescence. The Welsbach mantle mixture gave a little more, but very little more, than pure thoria. Where pure thoria gives a bright light, ceria gives practically none. Kathode rays appeared to reduce the oxides partly to the metallic state. A. D.

HEAT.

1684. *Thermal Conductivity of Ebonite and Glass.* **A. Dina.** (N. Cimento, 9. pp. 461–465, June, 1899.)—Observing that when strips of tinfoil were placed on glass or ebonite and heated, their fusion was retarded 40 and 10 per cent. respectively, owing to thermal conduction, the author devised a method of determining thermal conductivities of bad conductors in which the substance is first heated and then one of its surfaces suddenly cooled. The outward flow of heat depends upon the conductivity; and the amount of heat it possesses after a given interval can be measured with a calorimeter. The author shows how to calculate the conductivity from the calorimeter readings. He finds that of glass to be 0·152, and that of ebonite 0·023.

E. E. F.

1685. *Thermal Conductivity of Ice.* **P. Straneo.** (N. Cimento, 7. pp. 333–340, 1898.)—The author considers the methods hitherto employed to determine the conductivity of ice unsatisfactory, namely, those of Mitchell, De la Rive, Forbes, and F. Neumann. He first describes experiments made with cubes of ice of two different kinds. It appeared from these that ice often presents different phenomena according to direction, whether vertical or horizontal, arising from the position of the water during congelation. He then describes a second series of experiments made with long cylinders of ice, one cut with vertical the other with horizontal axis, in order to determine the different rates of conduction in the two cases. The coefficient of conductivity derived from the first series is 0·31. A small difference is found to arise from the direction in the second series. (See also 1898, Abstract No. 388.) S. H. B.

1686. *Temperature Changes of Glass and Thermometer Zero Points.* **L. Marchis.** (Zeitschr. Phys. Chem. 29. pp. 1–26, 1899.)—This is a German translation of the author's abstract (Mem. Soc. Scien. Bordeaux (5) 4) of a longer thesis, and much resembles a paper already abstracted (see 1899, Abstract No. 554). The position taken up is that the volume of a thermometer (or other piece of glass) kept at an absolutely constant temperature will itself remain absolutely constant: that any change in its volume at this temperature is due to an oscillation of its temperature: that if the thermometer be made to continually vary between two given temperatures its volume at each temperature will gradually alter to a limiting value which depends on the other: that this progress to a limit at either temperature is quickened by an oscillation of the temperature whenever, during this progress, the other given temperature is reached. The question is thus one of pure hysteresis, and the memoir is consequently based on Duhem's work (see 1898, Abstract No. 1228). Experimental results are cited in support of the theory. A second memoir will detail the work that has been done respecting the displacement of the zero-point, which is in ordinary cases ascribed to the unavoidable variations of temperature in a laboratory. (See also 1899, Abstract 1490.) R. E. B.

1687. *Constants of Normal Heptane.* **S. Young.** (Journ. Chem. Soc. 73. pp. 675–681, 1898.)—The vapour pressures at low and high temperatures, the specific volumes and critical constants of normal heptane are given in a set of tables. This substance, whose boiling-point is 98·43, and sp. gr. at 0° is 0·70048, has the following critical constants: temperature, 266·9°; pressure, 2041·5 cm.; density, 0·2344; volume of a gramme, 4·266 cc.; molecular volume, 425·7. The critical densities of isopentane, normal pentane, normal hexane, and normal heptane, are nearly identical. J. J. S.

1688. *Thermal Properties of Normal Pentane.* **J. Rose-Innes** and **S. Young.** (Phil. Mag. 47. pp. 353–367, and 48. pp. 213–214, August, 1899.)—Particulars of the data obtained in four series of determinations are given. These include (1) volumes of liquid to critical point; volumes above critical temperature to 280°; (2) volumes of unsaturated vapour from 140° to critical point; volumes above critical point to 280°; (3) volumes of vapour at and above 80°; (4) volumes of vapour at and above 40°. From the data deduced from the simultaneous observations of pressure and volume at various temperatures, the values of b and a in the equation $p=bT-a$ were obtained graphically. As in the case of previous results obtained for isopentane the deviations are very small at the largest and smallest volumes and about the critical volume, but are larger at intermediate volumes. The relation $p=bT-a$ at constant volume is a very close approximation to the truth. As with isopentane the molecular pressure a appears not to follow a continuous law, but passes abruptly from one law to another somewhere about vol. 3·4.

In the second paper the authors discuss the relations between the volume, temperature, and pressure of normal pentane. A comparison of the behaviour of isopentane and normal pentane is made. It is concluded that the difference of pressure between two isomeric substances at the same temperature and volume involves the same power of the density as the first deviation from Boyle's law, *i.e.*, the second power. J. J. S.

1689. *Thermal Properties of Isopentane.* **S. Young** (Zeitschr. Phys. Chem. 29. pp. 193–241, June, 1899.)—Three specimens of isopentane were very carefully purified, and measurements taken to trace out the characteristic equation $f(p, v, T)=0$. The measurements include the boiling-point under atmospheric pressure; the density at 0° and atmospheric temperature; the critical temperature and pressure; the vapour pressure from $-31°$ to $+28°$ by the dynamic method, and at higher temperatures by the pressure apparatus already described by the author; the specific volume of saturated vapour and liquid by the same apparatus and by heating a known mass of the substance in a sealed graduated tube (Trans. Ch. Soc. 59, 37. 63, 1201). The most difficult correction was for the varying pressure of mercury vapour at high temperatures, saturation not being reached during the course of an ordinary experiment. Full details are given of how this difficulty was met. The critical volume was found by the method of Cailletet and Mathias. $T_c=187°{\cdot}8$ $p_c=25020$ mm. $V_c=4{\cdot}266$ cc.

The relation, $p=a+bT$ (v const.), is nearly verified, but the deviations from it cannot be accounted for as experimental errors. The values of a and b are fully tabulated and represented graphically: they show a marked singularity, if not discontinuity, at $v=3{\cdot}2$ as was the case for ether. Tables are also given comparing isopentane and benzene in corresponding states; the agreement is very close. At the critical point the actual density is 3·73 times the theoretical, which agrees with the substances of the benzene group studied (3·65 to 3·83) and with carbon dioxide (3·62 according to Amagat). The molecules of isopentane are therefore presumably unassociated. R. A. L.

1690. *Thermostat.* **R. Rothe.** (Zeitschr. Instrumentenk. 19. pp. 143–146, 1899.)—The thermostat here described is the one used in the Reichsanstalt for comparing thermometers at temperatures up to 500° C. The heating is done electrically, a coil being placed in the oil or other fluid (oil up to 300°, air up to 500°) forming the bath containing the thermometers. For description of the stirring arrangement, the protection against loss of heat, and the other details of the apparatus reference must be made to the paper. J. B. H.

1691. *Biological Thermodynamics.* **A. Chauveau.** (Comptes Rendus, 129. pp. 249–258, July 31, 1899.)—The author has conducted experiments on the production of work and heat in muscular action, in specially constructed apparatus of large size. Three series of experiments are recorded in which (i.) a man works a friction wheel inside a calorimeter, and the entire production of heat and work is absorbed by the calorimeter; (ii.) the man remains inside the calorimeter, but the friction wheel is outside. In these two series the muscular action is that of walking upstairs. (iii.) The man is again inside the calorimeter, but the wheel is driven from outside in the opposite sense, so that the action is that of walking downstairs. Further, the evolution of water vapour and carbon dioxide was measured in order to estimate independently the liberation of chemical energy. In series (i.) the production of heat was 263 cals. per hour; in series (ii.) 199 cals., while the work "exported" from the calorimeter was estimated at 68 cals. This verifies, within the limit of experimental error, the application of the first law of thermodynamics to muscular action. In series (iii.) the production of heat was 170 cals. whilst the measurement of CO_2 exhaled show 257 cals. when the subject was doing positive work in agreement with series (i.) and 126 during negative work. It may therefore be concluded that when work is absorbed by the body the equivalent in heat is generated in it, besides the heat due to combustion of the tissues, although the proof of this point is not quantitatively exact. Electric heating was employed to calibrate the calorimeter.

R. A. L.

1692. *Heat-stuff, Energy and Entropy.* **O. Wiedeburg.** (Zeitschr. Phys. Chem. 29. pp. 27–50, 1899.)—As it is difficult to frame an exact idea of what entropy is, and as entropy does not conform to the conservation-law which applies to other quantities classed as "capacity-factors" in energetics, the author reverts to the idea of a heat-stuff, to which, he contends, the energy-idea is not antagonistic and by which the entropy-relations can be explained. (See also 1899, Abstract No. 62.) R. E. B.

1693. *Limits of the Solid State.* **G. Tammann.** (Wied. Annalen, 68. 3. pp. 553–583, July, and 68. 4. pp. 629–657, August, 1899.)—Experiments made upon a large number of organic substances show that as long as the heat of fusion is positive, the melting curves are convex towards the axis of pressures, and so are the transformation curves. In a single case, that of ammonium nitrate, the curvature of the transformation curve is in the opposite sense. This is accompanied by an anomaly in the specific heat. It is also evident that at temperatures and pressures where the heat of fusion is nearly or quite zero (acetic acid, diethylamine, water, silver iodide), the difference in the specific volumes of the liquid and the crystals is still considerable.

If the pressure increases and the melting curve ascends to higher temperatures, the following maximum fusing-points are indicated by extrapolation :—

Naphthalene	261°	and	11,500	kg. per sq. cm.
Carbonic acid... ...	76°	„	13,000	„
Ethylene dibromide ...	178°	„	12,900	„
Calcium chlorhydrate...	86°	„	10,000	„
Hydrocyanic acid ...	81°	„	7,400	„
Dimethyl ethyl carbinol	36·5°	„	4,400	„

In the last substance measurements could be carried close up to the maximum fusing-point.

Triple points, at which two polymorphous crystals were in equilibrium, were observed in carbonic acid, sulphur, and other bodies. Ammonium nitrate showed a triple point with an equilibrium between those crystalline forms at a temperature of 64·1° and a pressure of 930 kg. E. E. F.

1694. *Kinetic Theory of Liquids.* **G. Jäger.** (Wied. Annalen, 68. 3. pp. 615–617, July, 1899.)—The author defends his former paper against the criticism of W. Voigt. He points out that if molecules are assumed to be bodies of definite dimensions, and either perfectly elastic or perfectly hard, it is impossible to assume a diminution of their size a hundredfold on passing from the gaseous to the liquid state. E. E. F.

1695. *Mixture of Gases.* **P. Sacerdote.** (Journ. de Physique, 8. pp. 319–329, 1899.)—A similar paper to that referred to in Abstract No. 253, 1898. R. E. B.

SOUND.

1696. *Measurement of Sound.* **B. F. Sharpe.** (Science, 9. pp. 808–811, June 9, 1899.)—The method adopted was based upon the suggestion of Webster, that the optical arrangement of Michelson's refractometer, combined with an acoustical method employed by Wien (Wied. Ann. 1899, p. 835), might yield a sound-measuring apparatus of great sensitiveness. For this purpose, one totally reflecting mirror of the refractometer was made very small and light, and was mounted upon a thin glass plate, which formed a portion of the walls of a spherical Helmholtz resonator. A pure tone of the same pitch as the resonator causes the bands to vibrate with the same frequency. The fringes were made vertical and then cut down to a narrow horizontal line by means of a slit. This line was viewed with a telescope whose objective was small, and mounted upon the prong of a tuning-fork of the same pitch as the source of sound. It vibrated vertically, and so drew the line out again into a band of vertical fringes, which became inclined to the vertical as soon as the resonator received a sound of the same pitch. The inclination depended upon the intensity of the sound and the difference of phase. To obtain the maximum inclination the prongs of the telescope fork were slightly loaded so as to obtain low beats. Thus the phases of one vibration overtook those of the other very slowly, and consequently the interference bands were obtained sloping first to the right and then after an interval to the left, the changes occurring periodically and following each other as slowly as desired. By means of a suitable eyepiece with divided circle the angle of this slope could be measured, and gave immediately a means of measuring relative intensities. For photographic recording, the telescope with vibrating eyepiece was replaced by a fixed lens system which focussed a narrow band of fringes upon a sensitive film mounted upon a uniformly revolving cylinder in a manner similar to that employed by Raps. A pure, constant, and portable source of sound was obtained by driving a tuning-fork of about the same pitch as the note desired by an electromagnet with a current interrupted by a similar control-fork, electrically driven by the usual method of self-interruption. The first fork was fastened vertically upon a heavy iron base, and one of its prongs was connected to a circular thin iron plate, of approximately the same pitch as the fork, by means of a short stiff wire. This plate formed a side of a Helmholtz resonator, constructed to give the note desired, and rigidly supported. A very small vibration of the fork suffices to give a very loud tone, and the intensity may be governed by varying the current driving the source fork.

E. E. F.

1697. *Vibrations of Caoutchouc Strings.* **V. von Lang.** (Wied. Annalen, 68. 2. pp. 335–342, June, 1899.)—If a caoutchouc thread is stretched with both hands and plucked near the ear, it is noticed that after a certain point its pitch is only very slightly altered by further tension. This is intelligible when it is remembered that in caoutchouc there is always a certain interval during which the length of thread is proportional to the tension. By Taylor's formula the pitch is proportional to the square root of the ratio of tension to length. Hence the constancy of the pitch for that interval. The author tests this theory with the aid of bicycle pump tubes, and finds several maxima and minima of pitch. E. E. F.

1698. *Air Waves produced by a Pendulum.* **E. Ketteler.** (Wied. Annalen, 68. 1. pp. 74–91, 1899.)—The author investigates mathematically the action of a pendulum as a generator of air waves, and as a resonator to the same. The pendulum is conceived as a disc vibrating in an infinite tube, the cross-section of which it nearly fills up, and subject to a force varying with its displacement. It is found that air and pendulum always vibrate together, without lag. By conceiving the tube as returning into itself, the case is created of the pendulum resounding to its own vibrations. The investigation has an important bearing upon the theory of the tuning-fork and other acoustic appliances.

E. E. F.

1699. *Acoustic Resonators.* **A. Pochettino.** (Roma R. Accad. Lincei Atti, 8. pp. 260–264, 1899.)—The author investigates the damping coefficient in a resonator as depending upon the shape of its aperture, the addition of flanges, and the distance from the source. He finds that the shape of the aperture has very little influence, provided the size remains constant. As the diameter of the flange increases, the resonance increases for any proper note, and decreases for notes slightly out of tune. The resonance also subsists for a longer time. The same consequences are observed when the distance from the source is increased. E. E. F.

ELECTRICITY.

1700. *Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside.* **C. S. Whitehead.** (Phil. Mag. 48. pp. 165–180, August, 1899.)—We are to suppose an alternating current in a circular circuit whose axis passes through the centre of the conducting sphere. When the radius of the sphere is very great compared with the radius of the circuit, the sphere is in effect an infinite plane sheet. The author obtains expression for R_d the maximum value of the normal component of magnetic induction, and T_d the maximum value of the tangential induction. It appears that when d, the distance of the circuit from the plane, is very small compared with ρ, the distance of the point observed from the axis, R_d is very small compared with T_d. In induction telegraphy, assuming the infinite plane to be represented by sea water, this is exactly what happens. It is inferred that the best effect is obtained by making the receiving circuit vertical. The normal magnetic induction is shown to be much greater for sea water than for iron or copper. The general case when the radius of the sphere is not infinite is investigated. S. H. B.

1701. *Irreversible Radiation Processes.* **M. Planck.** (Berlin Akad. Sitzber. 25. pp. 440–480, 1899.)—This is the fifth and concluding memoir (see 1899, Abstract No. 268, &c.). We are to suppose a vacuum bounded by completely reflecting surfaces, in which exist electromagnetic waves, and one or more resonators or dipols. If f is the moment at time t of a resonator whose oscillation period is ν, Z the intensity of the field resolved in direction of the resonator, then the known equation for f is—

$$\frac{d^2f}{dt^2}+2\sigma\nu\frac{df}{dt}+4\pi^2\nu^2f=\frac{3c^3\sigma}{4\pi^2\nu}Z,$$

in which c is the velocity of light, and σ the damping of the resonator, understood in this case to arise, not in any degree from ohmic resistance, but from the emission of energy by the resonator.

In Part I. the author gives a solution of this equation, from which he shows that, σ being very small, only those oscillations of the medium sensibly affect the resonator, whose period is equal, or nearly equal, to that of the resonator. An expression is then obtained for the energy of the resonator, and for its rate of absorption and emission of energy. The intensity of the exciting oscillation in the field is then calculated as a function of the period or inverse wave-length.

Natural radiation is defined as follows: The energy of the resonator, denoted by U, contains in its expression certain variables which vary rapidly with the time, *i.e.*, change sensibly during the period of oscillation. It is assumed that in lieu of these variables we may use their mean values over a time very long compared with the oscillation period, and that is defined to be natural radiation.

The fundamental equation of the theory is then given in the form—

$$\frac{dU}{dt}+2\sigma\nu U=\frac{3c^3\sigma}{16\pi^2\nu}I,$$

where I is that part of the energy of the field which arises from oscillations of the period ν.

In Part II. expressions are given for the energy per unit of volume of the field, and for the intensity of the exciting oscillations, having regard to the direction of polarisation, also, under the same circumstances, for the energy absorbed and emitted by the resonator.

The entropy S of a resonator is defined analogously to Boltzmann's **H** function as—

$$S^1=-\frac{U}{a\nu}\log_e\frac{U}{b\nu}$$

where a and b are constants, and e the base of the natural logarithms. The entropy s per unit volume of the field is defined in the same way as the energy, every pencil of rays being assumed to possess and to carry with it, and to communicate entropy, just as it possesses and carries and communicates energy. It is then shown that, given a number of resonators in the field, and any system of polarisation in the medium, the entropy is either constant or increases. The stationary state is reached when the entropy is constant, *i.e.*, maximum, and this state is shown to depend on a single variable θ, namely, $\frac{1}{a\nu}\log\frac{U}{b\nu}$.

In Part III., which relates to thermodynamics, the temperature is defined as $\frac{dQ}{d\theta}$, where θ is the variable above mentioned, and Q a small addition of heat.

Considering the relation between radiation and temperature, Planck obtains the result given by Wien and others, namely—

$$E\lambda=\frac{2c^2b}{\lambda^5}\varepsilon^{-\frac{ac}{\lambda\theta}}$$

expressing the energy of that part of the spectrum which has wavelength λ. S. H. B.

1702. *Dimensions of Electrical Units.* **K. Schreber.** (Wied. Annalen, 68. 3. pp. 607–614, July, 1899.)—The reduction of the physical units and measurements to the fundamental units of mass, space, and time has only been fully carried out in mechanics. Measurements connected with sound, light, heat, magnetism, and electricity are still based upon arbitrary units, and the author maintains that their reduction to the fundamental units is an impossibility. The equations of magnetic and electrostatic attraction formulated by Coulomb have, as pointed out some time ago by Rücker, different constants, whose dimensions used to be suppressed, with the result that different dimensions were given to the electromagnetic quantities, according as to whether they were founded upon the electrostatic or the electromagnetic system of units. The discovery of new relations, such as the action of a magnet upon a current, does not solve the difficulty, since it introduces another constant of unknown dimensions. E. E. F.

1703. *Networks of Conductors of Finite Transverse Dimensions.* **J. B. Pomey.** (Écl. Électr. 19. pp. 169–172, 1899.)—A mathematical paper containing an extension of some results of the electrostatic theory of a system of conductors, as developed by Maxwell, to the case of a system of tubular conductors conveying currents. A. H.

1704. *Theories of Atmospheric Electricity.* **Chauveau.** (Paris, Soc. Franc. Phys. Bull. 133. pp. 2–3, June, 1899.)—A very brief *résumé* of the theories advanced. The author suggests that the complex phenomena need not all have the same cause. Peltier's dissipation of negative electricity by water vapour would help to explain the electricity of the lower strata. As regards the positive charges of cirrus clouds, we have the hypotheses of Sohncke and of Brillouin. But we cannot account for the fact, established by balloon observations, that for elevations up to 7,000 m. the electric potential first rises and then assumes a constant value. Attention is drawn to Lenard's hypothesis of a positive electrification of the air by the spray from the ocean waves, to Edlund's unipolar induction, which seems to explain auroral displays, and to Rowland's observation that the mechanical transport of electrified masses generates currents. Further prolonged observations are needed, such as those conducted by Andrée at Spitzbergen in 1882–1883. H. B.

1705. *Atmospheric Potential.* **E. Oddone.** (N. Cimento, 9. pp. 448–450, June, 1899.)—The author points out that the potential increases as we ascend in the atmosphere, and that it is not the potential, but the potential-gradient which diminishes. A. D.

1706. *Atmospheric Potential.* **H. Pellat.** (Paris, Soc. Franc. Phys. Bull. 134. pp. 1–2, June, 1899.)—The apparatus used by the author consists of a cylindrical brass tube about 25 cm. high and 20 cm. in diameter, surrounded at half its height by a circular gas-burner having a large number of holes, so that the flame is continuous. Even when exposed to a high wind the flame is not extinguished, one part being always protected by the cylinder and serving to relight the rest. Successful experiments have been made on the summit of the tower of the Sorbonne during a gale. The apparatus follows very rapidly the variations of potential of the air. A laboratory experiment shows that a variation of potential produced artificially is indicated after 15 seconds to within 0·4 per cent. of its value. A water-dropping electrometer using 60 litres per day would require 25 times that interval to give the same indication. The flame apparatus does not require very rigid insulation, an ebonite arrangement similar to telegraph insulators being sufficient.

E. E. F.

1707. *Electrostatic Capacity of Two Parallel Wires.* **J. B. Pomey.** (Écl. Électr. 19. pp. 131–133, 1899.)—The author refers to the previous work of Blavier (Annales Télégraphiques, 1882) on this subject, and then gives an account of his own method of attacking the problem, which involves the use of functions of a complex variable. He obtains the following expression for the capacity C per unit length of the two parallel wires—

$$C = \frac{k}{2 \log (a + \sqrt{a^2 - 1})}$$

in which k stands for the inductivity of the medium surrounding the wires, and $a = (d^2 - R^2 - R'^2)/2RR'$, where d is the distance between the centres of the two wires whose radii are R and R′ respectively.

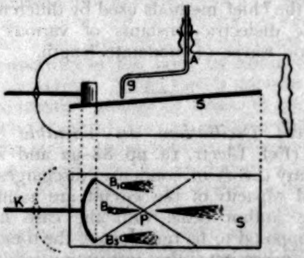
A. H.

1708. *High-Frequency Point Discharges.* **F. Himstedt.** (Wied. Annalen, 68. 2. pp. 294–305, June, 1899.)—The author was the first to prove that if one pole of a Tesla transformer is connected with a point, and the other with a disc placed at such a distance that no spark is able to pass from one to the other, the disc is charged positively in air or oxygen, and negatively in all other gases. This result is independent of the direction of the primary current in the coil, or of the connection of the poles, the slight differences observed by Pflüger being due to a lack of symmetry in the experimental arrangement. Further investigations by the author led to very contradictory results, but these were due to a curious circumstance hitherto unobserved. He found that the disc is charged positively, negatively, or not at all, according to the distance between the point and the disc. To explain this, the author makes the assumption that a fine point attached to the pole of a Tesla transformer gives out a greater quantity of positive electricity than negative, and further, that the negative electricity is capable of being propagated to a greater distance through air than positive electricity. These rules characterise the discharges no matter what may be the nature of the gas, the only difference being that the transition takes place at different distances in different gases. E. E. F.

1709. *Flexible Spark Discharges.* **E. Lecher.** (Wied. Annalen, 68. 3. pp. 623–628, July, 1899.)—The author describes some extraordinary and beautiful phenomena obtained with a Wehnelt interrupter and a magnetic field. He finds that the secondary current obtained with a Wehnelt interrupter is unidirectional, and corresponds with the break of the primary current only. Hence the secondary sparks may be employed for demonstrating the influence of a magnetic field upon a flexible conductor, a function which it fulfils with great brilliance of effect. It is well known that every spark discharge, as well as the arc, shows an upward curvature, partly at least due to an ascending current of heated air. If the discharge obtained with the Wehnelt interrupter takes place between two wires slightly inclined to each other, and symmetrical as regards the vertical, the lower ends being the nearest, the discharge sets in at the bottom, ascends under the influence of the hot air, and finally snaps at the top, to begin again as before. But when a powerful magnetic field is created at right angles to the plane of the wires the process is greatly accelerated, the lines of discharge succeeding each other at such a rate that they appear to form one flaming surface. On reversing the field the discharge remains at the bottom, and even curves downward unless much heat is developed. Another pretty effect is obtained by letting the discharge take place between a disc placed at the centre and in the plane of a vertical circular wire. The discharge normally goes straight up from the disc to the wire. But, on exciting the magnet, a kind of wheel is produced, having curved luminous spokes which revolve rapidly in a direction determined by the sign of the field. The spark lines are much closer together than shown in the figure. The author describes a number of other striking experiments illustrating the behaviour of these flexible discharge threads. They make good lecture experiments. E. E. F.

1710. *Phillips Phenomenon.* **S. P. Thompson.** (Electrician, 43. pp. 412–413, July 14, 1899.)—The author suggests an explanation of the Phillips Phenomenon (for which see 1899, Abstract No. 683). The direction of rotation is consistent with the assumption that a current, or convective discharge, flows radially inwards. To account for the occurrence of the discharge only after exciting the magnetic field, it is suggested that the growing magnetic field sets up electrostatic forces, which act on the electric charges previously stationary. J. L. H.

1711. *Kathode Rays.* **A. Wehnelt.** (Wied. Annalen, 68. 3. pp. 584–593, July, 1899.)—The author endeavours to obtain a true explanation of the contradictory results obtained with regard to the shadows cast by kathode rays. He finds that the kathode rays which issue from the kathode in a direction normal to its surface cross each other freely, and do not mutually influence each other's direction. They therefore produce reversed shadows of intervening obstacles. The upright shadows occasionally met with are due to another class of rays, which run parallel to the axis of the tube. The difference between the two classes of rays is brought out clearly by mounting a chalk screen S (see diagram) in a position nearly parallel to the axis of the tube. A glass rod *g*, capable of turning about the shaft A, casts a shadow of the shape shown at B_1, B_2, B_3, according to the kind of beam in which it is inserted. The kathode rays cross the point *p*.



E. E. F.

1712. *New Vacuum Phenomenon.* **L. Fomm.** (Wied. Annalen, 68. 3. pp. 620–622, July, 1899.)—When a vacuum tube is provided with two external electrodes in the shape of rings of thin wire surrounding the ends of a long thin tube, and is gradually exhausted, the well-known succession of phenomena is observed—spark discharge, positive and negative light, formation of dark space, and stratification of the positive light. Then blue rings appear, concentric with the wire rings, and enclosing particles of positive light, which gradually disappear until the blue light fills the whole cross section. As the pressure diminishes still further the blue light detaches itself from the glass walls, and expands laterally while contracting in the plane of the rings, until a greenish-blue beam is formed proceeding in the direction of the other ring, but always perpendicular to the plane of the generating ring, whatever be the orientation of that ring with respect to the axis of the tube. The greyish-blue beam has all the properties of kathode rays, though its generation must necessarily be a very different process from that of the kathode rays. It produces vivid phosphorescence where it impinges upon the glass wall, sets in motion a little paddle wheel mounted in its path, and is deflected by a magnet, the centre of rotation being the geometrical centre of the ring. E. E. F.

1713. *Dielectric-Constants Determined by Electric Waves.* **L. Barbillion.** (Écl. Électr. 19. pp. 326–333, June 3, 1899.) —A *résumé* of the chief methods used by different observers for determining the dielectric-constants of various substances by means of electric waves of moderate length. E. H. B.

1714. *Electrical Oscillations in Variable Circuits.* **M. Petrovitch.** (Écl. Électr. 19. pp. 88–92 and 213–221, 1899.) —In the ordinary theory of condenser discharges the resistance, inductance, and capacity of the circuit are assumed to remain constant. The author deals with the case in which these quantities are supposed to be functions of the time. The method used does not necessitate the integration of the differential equation, and is based on certain properties of the integrals of linear differential equations of the second order in which the second term is absent, most of these properties having been discovered by Sturm. It is impossible to give a satisfactory abstract of the mathematical details of the paper. A. H.

1715. *Electrical Radiation.* **J. E. Taylor.** (Elect. Rev. 44. pp. 794–795 and 799–800, 1899.)—The theories of electrical radiation, especially as regards their application to wireless telegraphy, are here summed up in non-mathematical form, on the lines of Hertz, Lodge, J. J. Thomson, and Poynting. R. A.

1716. *Cohering Action of Metals.* **J. C. Bose.** (Roy. Soc. Proc. 65. pp. 166–172, July, 1899.)—The sensitiveness depends on the proper adjustment of the E.M.F. and pressure of contact for each particular receiver. All metals exhibit contact sensitiveness to electric radiation, the general tendency being towards a diminution of resistance. Potassium is an exception: it exhibits an increase of resistance under the action of radiation, and also a remarkable power of self-recovery. The allied metals also exhibit, to a less extent, this increase of resistance. In damp climates coherers made of iron or steel become oxidised on the surface, and this change causes a diminution of the sensitiveness of the coherer. This can be avoided by coating the spirals with deposits of other metals, the sensitiveness depending on the coating metal and not on the substratum. Highly sensitive coherers can be made of fine silver threads coated electrolytically with cobalt.

D. E. J.

1717. *Action of Coherers.* **T. Sundorph.** (Wied. Annalen, 68. 3. pp. 594–597, July, 1899.)—The author demonstrates in a simple manner the formation of connecting chains of particles in a coherer. He attaches two metallic rods to a horizontal glass plate, with a distance of a few millimeters between them, and fills up the gap with a thin layer of powdered nickel or iron. He then imparts conductivity to the layer by means of sparking or by repeated short-circuiting. When that is done he removes the greater part of the metallic powder by means of a feeble magnet. What remains forms a set of rows of particles cohering lightly. If the magnet is too strong, these rows are broken up. The fact that the higher conductivity may be produced by short-circuiting suggests that the E.M.F. due to the break of the short-circuit produces sparking in the powder, which welds the particles together. On tapping the powder very gently, the high conductivity is reduced to a certain extent by the partial breaking up of the connecting links. But this may be remedied by diminishing the resistance in the remainder of the circuit. The fact that heating destroys the conductivity, while cooling does not, is explained by the author on the ground of the longitudinal pressure which breaks the heated rods, while they withstand a tension produced by cooling. E. E. F.

1718. *Coherers.* **T. Tommasina.** (Comptes Rendus, 129. pp. 40–42, July 3, 1899.)—The process of coherence consists, in the author's opinion, in the formation of chains of filings; and the formation of the chains depends upon the orientation of the unit fragments under the influence of the electric field between the electrodes. The chains are formed less easily in air than in liquid dielectrics. In distilled water chains 20 cms. long have been made; the action is in this case not instantaneous, but it requires less than 1 sec. of time. The filings are first sprinkled over a large horizontal board. A coil giving a spark of 35 cm. was used by the author. The discharge, apparently, was caused to take place close to the board; the distance and position of the electrodes is not definitely stated. By diminishing the current it is possible to form a set of chains; if the current is then gradually increased, one chain at last completes the circuit between the electrodes; the immediate effect is to break up all but this chain into fragments, and to cause all movement among the filings to cease. So long as the current is continued this chain is not easily destroyed, even when violently shaken; but if the current is broken, a very slight shake disintegrates it. Similar effects can be obtained by using a V-shaped glass tube to contain the distilled water. In another form of the experiment, filings of silver are sprinkled over a large flat dish, containing distilled water to 3 or 4 mm. Two aluminium wires are used as electrodes. Under the action of a current less intense than in the preceding experiments, chains of filings can be caused to radiate from the electrodes, perfectly identical in form with the magnetic lines of force between the poles of a magnet. But it is necessary to continually break the complete chains as they form, otherwise a perfect *fantôme* cannot be obtained. R. A.

1719. *New Form of Coherer.* **A. G. Dell.** (Elect. World and Engineer, 33. p. 839, June 17, 1899.)—A conical-shaped wooden vessel carries two wire terminals which pass through the sides, and is filled with brass filings which escape at the orifice formed by the lower part of the cone. As the filings run out they cause decoherence along the chains of filings between the points of the brass wires. The author finds it difficult to keep the filings running without frequent tapping, and suggests that by using glass instead of wood (*e.g.*, a vessel shaped like an hour-glass) this difficulty might be overcome. A. H.

1720. *Photographic Study of the Arc.* **N. H. Brown.** (Phys. Rev. 7. pp. 210–216, 1898.)—This paper is illustrated by plates taken from the photographs obtained.

An alternating arc is focussed by a lens on to a photographic plate moving rapidly horizontally. In some cases a narrow vertical slit is placed just in front of the plate giving better definition. The results show, not only that the arc is out part of the time, but also that the lighting up does not take place across the whole arc space at the same instant, starting from one side one time and the opposite side the next time. A simple calculation shows that this light travelled across the arc with a velocity of about 300 inches per second from the negative carbon towards the positive. From results obtained with the narrow slit in front of the plate, there appears to be two light fronts, one from each carbon, and one of them starts about $\frac{1}{1000}$ of a second before the other. They travel with different velocities, the negative at about

300 and the positive at 500 inches per second. Pictures were also taken of a whole arc, a disc with four slots in it being rapidly rotated in front of the lens at about 15,000 revolutions per minute, there being thus about 1,000 exposures (of $\frac{1}{25000}$ second each) per second, or about 8 images of the arc per complete period. The results of this experiment bear out the previous conclusions. A further experiment was made with a continuous current arc. This was short-circuited during part of the time while the plate was moving: before the plate had entirely passed across, the short circuit was broken, relighting the arc. When the arc is first broken an abrupt line is visible, showing a very sudden diminution of the light; the fading light from that line forward is the same as with the alternating arc. When the arc is re-formed, its difference from the alternating arc is very marked; the light does not reach the centre quite as soon as it leaves the sides, but very much sooner than in the case of the alternating arc. Also the light from the positive carbon is ahead of the negative, while in the alternating arc the negative is ahead of the positive. E. C. R.

1721. *Effect of Torsion on Electrical Resistance of Alloys.* **C. de Szily.** (Comptes Rendus, 128. pp. 927–930, 1899.)—In order to investigate the effect of variations of torsion upon the resistance of wires, it is necessary to eliminate the effects of temperature changes. As this is rather difficult, the author experimented with constantan, an alloy which has a temperature coefficient that can be neglected. The results of a great many experiments show that the electrical resistance augments as the angle of torsion increases. Up to the elastic limit of the metal, the variation appears to be directly proportional to the angle of torsion. But beyond the elastic limit of the metal, the resistance varies more rapidly than the torsion.

The author also examines the more important question as to whether the electrical resistance of such a stretched wire remains constant with time. In the case of constantan it is found that after being subjected to and maintained in torsion, the resistance very slowly diminishes with time. It is also found that a wire (presumably a wire of constantan) which, after dextral torsion, has been relieved, and then twisted by sinistral torsion, to the zero position, diminishes in resistance more quickly than when the initial twist is maintained. When a wire has been twisted beyond the elastic limit, and has then been allowed to untwist itself, the subsequent changes of resistances, for increasing angles of torsion, are less than those that occur during the first twist. Comparing torsional effects for wires of different diameter (presumably of constantan), it is found that the electrical resistance-changes augment more rapidly than the diameters. R. A.

1722. *Flames Containing Salt Vapours.* **H. A. Wilson.** (Roy. Soc. Proc. 65. pp. 120–123, June, 1899.)—Observations upon the conductivity of such flames. Ionisation takes place at the surfaces of the glowing electrodes and not throughout the volume of the flame. The velocity of the negative ions in the flame is very much greater than the corresponding velocity of the positive ions (about 1,000 as against 60 cm./sec. per volt/cm., for salts of Li, Na, K, Rb, Cs). Those ions which in solutions carry equal charges have equal velocities in the gaseous state; but have less velocities than those calculated for single atoms. A. D.

1723. *Measurement of Battery Insulation.* **C. Liebenow.** (Elektrotechn. Ztschr. 20. pp. 360–362, 1899. A paper read before the Elektrotechnischen Vereins, April 25, 1899.)—In the usual method of testing the insulation resistance of a battery of accumulators by placing a voltmeter between earth and the two poles of the battery in turn, the leakage is all assumed to be from one point, whereas the fault is really split up into many parts. In examining the relations which exist, we may neglect the internal resistance of the battery as compared with its insulation resistance, and we can therefore regard the battery as a resistanceless conductor, along which a series of E.M.Fs. are arranged.

If $l_1, l_2 \ldots l_n$, are the conductivities of small parts of the battery between which the difference of potential is de (where $n.de=E$), and if i_1 and i_2 are respectively the currents to earth through a resistance-less ammeter from the two poles of the battery, then :—

$$i_1=l_1\,de+2.l_2\,de+3.l_3\,de+\ldots+(n-2).l_{(n-2)}de+(n-l).l_{(n-1)}de$$
$$+n.l_n\,de.$$

$$i_2=n.l_0\,de+(n-l).l_1\,de+\ \ldots\ +2.l_{(n-2)}\,de+l_{(n-1)}\,de.$$

Adding, we get $i_1+i_2=n.de\,\Sigma l=EL=\frac{E}{W}$, where E, W, and L, are respectively the E.M.F., resistance, and conductivity of the whole battery. If, however, accuracy is desired in the case of a very high insulation resistance, we must use a sensitive ammeter or galvanometer whose resistance will not be negligible. We must then insert an auxiliary battery, very carefully insulated, between the galvanometer and the main battery in such a way that their E.M.Fs. add. Then if e and w are the E.M.F. and resistance of the auxiliary battery, and if w_1 is the resistance of the galvanometer, then $W+w+w_1=\frac{E+2e}{i_1+i_2}$.

If w and w_1 are not known, we can put an auxiliary galvanometer directly between the pole being measured and earth. If we now adjust a variable resistance between the ammeter and auxiliary battery until no current passes through the auxiliary galvanometer, then the simple formula $W = \frac{E}{i_1 + i_2}$ again holds.

E. H. C.-H.

1724. *Electrical Measurements with Alternating Currents.* **H. A. Rowland** and **T. D. Penniman.** (Amer. Journ. Sci. 8. pp. 35–57, July, 1899.)—The paper details the results of measurements of capacity and self-induction by the methods published by Rowland (Amer. Journ. Sci. 4. p. 429, December, 1897; Phil. Mag. January, 1898. See 1898, Abstract No. 144), employing alternating currents and an electro-dynamometer. The authors first tried their method, No. 25 (*loc. cit.*), for the absolute measurement of self-induction and capacity in terms of the electromagnetic units. With self-induction the results were very concordant, agreeing within the accuracy of the frequency measurements, *i.e.*, to within 1 per cent. With capacity the determinations were vitiated by the absorption effect of the paraffined-paper condensers adopted.

Maxwell's formula shows that absorption may be treated as an added resistance which is constant for a given frequency, and the values of this for different frequencies were calculated, and found to agree well with the values found by direct measurement. The resistance increases rapidly with decrease of frequency; thus a 5-mf. condenser had an absorption resistance of about 5 ohms at a frequency of 130 ∿ and 140 ohms at 14 ∿. It also increases with the temperature of the condenser, for instance, after heating the condenser for one hour before a hot-air pipe, the resistance increased about 50 per cent.

An improved method is then described specially suitable for measuring absorption resistances.

The rest of the paper consists of detailed results of experiments with methods 12 and 6, zero methods for the comparison of self-inductances with one another and with capacity; different determinations agree to within 0·1 per cent. G. H. Ba.

1725. *Polarisation of de-ærated Water.* **R. Federico.** (N. Cimento, 9. pp. 191–206, 1899.)—The maximum E.M.F. of polarisation is less in water which contains gas in solution than in water free from gas (obtained by distilling crystallised carbonate of soda). Among oxygen, hydrogen, nitrogen, and air, oxygen has the greatest effect, then air, then hydrogen, and the action of nitrogen is not sensible. The action of air seems to depend upon the oxygen in it. A. D.

1726. *Polarisation of Dielectrics.* **Liénard.** (Comptes Rendus, 128. pp. 1568–1569, June 26, 1899.)—The author shows that not only does the theory of the fictitious polarisation of dielectrics lead to the same consequences as the other theories in one case (see Pellat, Science Abstracts No. 1159, 1899), but that it does so in all cases. E. E. F.

1727. *Electro-chemical Equivalent of Silver.* **G. W. Patterson, Jr.**, and **K. E. Guthe.** (Amer. Assoc. Proc. 47. pp. 154–175, 1898.)—In measurements of the electrochemical equivalent of silver the value has usually depended upon the accurate knowledge either of the acceleration due to gravity or of the horizontal intensity of the earth's magnetic field. The authors have obtained a value independent of g or H by balancing the moment due to the electrodynamic action of the two coils of an absolute electrodynamometer, against the torsional moment of a wire with very small elastic fatigue. The measurements are finally reduced to measurements of mass and length and the authors believe their result to be accurate to 1 in 5,000.

In the determination, Poggendorff's potentiometer method was used for comparing electromotive forces. First the ratio was found between the E.M.F. of two Carhart-Clark cells immersed in a large water-bath and the potential difference at the terminals of a coil of manganin wire, when a current flowed through it which just balanced the torsional moment of the suspending wire of the electrodynamometer due to one complete twist of the torsion head. The absolute value of this current was calculated from the instrument. Let I be the calculated current, E the E.M.F. of the cells, R_1 the resistance necessary to balance E, R_2 the resistance necessary to balance the potential difference due to I, R the resistance of the manganin coil, then—

$$I = \frac{R_2 E}{R_1 R}.$$

Secondly, the E.M.F. of the cells was balanced against the potential difference due to the silver depositing current. Let I_1 be this current, R'_1 and R'_2 the resistances necessary for the balances, E and R the same as before, then—

$$I_1 = \frac{R'_2}{R'_1} \cdot \frac{E}{R}.$$

The silver deposited by the current I is—

$$q = zI_1 t \text{ grammes},$$

where z is the electrochemical equivalent of silver, but—

$$I_1 = I\frac{R_1}{R_2} \cdot \frac{R'_2}{R'_1}.$$

therefore—

$$z = \frac{q}{It} \cdot \frac{R'_1}{R_1} \cdot \frac{R_2}{R'_2},$$

and the result is independent of the absolute value of the E.M.F. of the standard cells and of the manganin resistance coil.

A full account is given of the construction and adjustment of the electrodynamometer, the determination of the torsional coefficient of the phosphor-bronze suspension, and of the periods of torsional vibration of the system, as well as the influence of temperature upon the period. In the final experiments the moment of torsion due to a complete twist of the wire was balanced against the electrodynamic action between the two coils of the electrodynamometer.

The value found for the electrochemical equivalent of silver is—

$$z = 0{\cdot}0011192 \text{ grammes.}$$

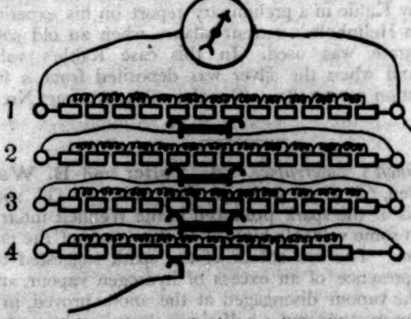
This is about $\frac{1}{6}$ per cent. larger than the accepted value. It agrees with the average value of Pellat and Potier, and with the value given by Kahle in a preliminary report on his experiments in Berlin with Helmholtz's current-balance when an old solution of silver nitrate was used. In this case Kahle's value is 0·0011193, and when the silver was deposited from a freshly prepared solution 0·0011182. (See also 1899, Abstract No. 109.)

J. J. S.

1728. *Wehnelt's Interrupter.* **A. Voller and B. Walter.** (Wied. Annalen, 68. 3. pp. 526–552, July, 1899.)—The spectroscopic analysis of the spark produced in the Wehnelt interrupter at break gives some valuable hints as to the nature of the process of interruption. The red colour of the spark suggested to the authors the presence of an excess of hydrogen vapour, and an analysis of the vapour disengaged at the anode proved, in fact, that its amount was two and a half times the normal amount demanded by Faraday's law. The hydrogen lines are very clearly evident in the spectrum. Platinum lines are also distinctly visible, and very pure and intense spectra of other metals may be produced by putting them in place of the platinum, and especially by reversing the ordinary action of the cell and making them kathodes. The presence of the hydrogen and of the sodium lines is not a disadvantage, as these are easily located and serve as lines of reference. By choosing a suitable electrolyte, the rapid disintegration of the majority of metals can be avoided. It should also be borne in mind that the spectrum lines of a metal may be obtained in two different ways with the same induction coil, by putting the cell either in the primary or the secondary circuit. E. E. F.

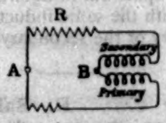
1729. *Concentration Cells.* **R. Salvadori.** (Roma R. Accad. Lincei Atti, 8. pp. 452–454, 1899.)—E.M.Fs. are given of cells made up of zinc electrodes surrounded by solutions of hydrochloric acid or trichloracetic acid of various concentrations, the solvents being water, alcohol, acetone, benzol, or ether. Also of cells containing KCl dissolved in those organic liquids, and provided with copper and zinc electrodes. E. E. F.

1730. *Universal Shunt.* (Elect. Rev. 44. p. 715, 1899.)—This is a description of a special universal shunt of the Ayrton-Mather form designed by Sullivan, in which the principle of the Thomson-Varley slide resistance is applied. Eleven coils of 1,000 ohms each are employed and the subdivision is carried down to one ohm. The accompanying figure shows the method of connection. The actual connections are made by means of sliding contacts over the studs of four sets of coils, No. 1 set of which contains eleven coils of 1,000 ohms each, No. 2 eleven coils of 200 ohms, No. 3 eleven coils of 40 ohms, and No. 4 ten coils of 8 ohms each. Two sliding contact springs insulated from each other ride over and embrace two coils of Nos. 1, 2, and 3 sets, and each pair of coils so embraced is permanently in parallel with all the coils in the next lower set. No. 4 sliding contact is a single one.



The box contains in addition an independent coil of 100,000 ohms. W. G. R.

1731. *Production of Leading Currents.* **O. Spitzer.** (Zeitschr. Elektrotechn. Wien, 17. pp. 213–216, 1899.)—In a given non-inductive circuit, R (see fig.), to produce a current in advance of the P.D. between two points A and B, without the use of condensers or synchronous motors. The author solves this problem by connecting the secondary of a transformer in series with R between A and B, the primary being connected in series with another non-inductive resistance between the same two points. By varying the resistance in series with the primary, the phase



relation of the current in R to the P.D. between A and B may be varied. The theory of the arrangement is fully worked out, and is extended to the case of an inductive circuit. A. H.

1732. *Alternating Current Circuits.* **De Bast.** (Bull. Ass. Ing. El. Liège, 10. pp. 48–84. 133–160, 233–255, 1898–1899.)—This paper contains elementary proofs of the relations between current, electromotive force, and reactance in circuits containing resistance, inductance, and capacity, either separately or in combination. W. G. R.

1733. *Electromotive Force on Mixing Liquids in a Magnetic Field.* **R. Blondlot.** (Comptes Rendus, 128. pp. 901–904, 1899.)—A rectangular vessel, 18 × 12 × 23 cm. deep, is filled to a depth of 3 cm. with a concentrated solution of zinc sulphate, the remainder being filled with a weak solution of the same salt, care being taken to avoid mixing. Two glass tubes pass through two of the opposite vertical faces at a height of 4 cm. from the base. These tubes are closed at the outer ends by paper parchment and are filled with solution from the vessel itself. They are bent downwards so that the ends dip into two little vessels containing a solution of zinc sulphate, each of these little vessels also containing an electrode of zinc amalgam. These electrodes are connected to the terminals of a capillary electrometer. The large vessel is placed between the poles of an electromagnet so that the lines of force are horizontal and parallel to the two sides containing the tube attachments.

A stirrer in the shape of a T square is now put into the liquid and as soon as any stirring takes place a difference of potential is noticed on the electrometer, this difference of potential changing sign with a reversal of the magnetic field. The difference of potential disappears when the stirring stops, and also when the magnetic field is removed. If we suppose a person lying on his right side in the vessel and facing the north-seeking pole of the magnet, then the positive electrode is at his head. The expression for the E.M.F. due to induction between the terminals is an integral, containing, among other things, the variable conductivity of the solution. If we remember that the mean effect of the stirring produces homogeneity, it is seen that this integral is not zero, but has a positive value that agrees with the experiments.

J. B. H.

1734. *Magnetic Inclination in Ancient Times.* **G. Folgheraiter.** (Roma R. Accad. Lincei Atti, 8. pp. 269–275, 1899.)—The article is an amplification and continuation of a paper referred to in Abstract No. 1039 (1899). In Greece during the seventh century B.C., the *south* pole of the dipping needle probably dipped downwards. This is different from its present behaviour. A. Gs.

1735. *Momentary Magnetisation.* **W. Kaufmann.** (Verh. Deutsch. Phys. Gesell. 1. pp. 42–46, 1899.)—If the needle of a magnetometer is replaced by an oscillating coil, no deflecting couple acts upon the latter unless it is traversed by a current. If an interrupter attached to the shaft of alternator is inserted in the circuit of the coil, which only makes the circuit at a definite phase, the force exerted by the magnet upon the coil is proportional to the instantaneous magnetisation of that phase. The author describes a magnetometer based upon this principle by which he has succeeded in showing that the hysteresis curves deduced from instantaneous values are identical with the ordinary ones. E. E. F.

1736. *Effect of Temperature on Hysteresis.* **A. H. Thiessen.** (Phys. Rev. 8. pp 65–79, 1899, Abstract in Électricien, 17. pp. 375–377, June 17, 1899.)—These experiments, made at temperatures of 100° C., ordinary temperature, and about $-80°$ C., show that the loss of energy dissipated by hysteresis increases as the temperature diminishes, but only when the induction is high enough to make the iron nearly saturated. When the induction is weak, the results are quite different, as the hysteresis loss diminishes with the temperature. Curves given in the paper show pretty clearly the reason of this phenomenon. The magnetising force being the same, the induction diminishes with the temperature as well as the hysteresis loss. For example, at a temperature of 97° C. the induction is 2,400, and the loss of energy 433 ergs; at 21° C. the induction is 1,900 and the loss 371 ergs; and at $-78°$ C. the induction is 1,500 and the loss 266 ergs.

The diminution of the hysteresis losses is explained by the diminution of the induction for the same magnetising force. It is pretty certain that Steinmetz's law $\gamma = B^{1.6}$ holds at all temperatures between $\pm 100°$ C.

It follows from the above, that if a transformer is worked at a low induction, the losses in the iron will augment as it heats up; if, however, it is worked at a sufficiently high induction the losses will be independent of the temperature.

Again, to magnetise a piece of steel, if only a weak magnetising force is at disposal, it is best to work at a temperature of about 100° C. E. C. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1737. *Victorium, a New Element.* **W. Crookes.** (Roy. Soc. Proc. 65. pp. 237–243, July, 1899.)—Crude yttria is roughly freed by the double potassium sulphate method from earths of the cerium group, then subjected to fractionation, the important point being that the agent is changed when the one process has been in operation for some time. In the first stage the nitrates are fused till partially decomposed, and the insoluble basic salt separated by water from the undecomposed portion. This is repeated as long as the spectra of the fractions reveal progressive change. The more insoluble of the middle fractions have been gradually acquiring a distinctive spectrum; they are united and treated to a second series of fractionations by crystallisation of the oxalates. Photo-spectroscopic tests are constantly taken, and portions mixed according to the data thus obtained, to avoid lateral spreading as much as possible. In the third stage the selected oxalates are turned into nitrates and again fractionally separated by fusion. Finally the potassium sulphate method is once more applied till no more alteration in the spectrum is observed. A diagram is given.

Victoria (announced by the author at the British Association in September last under the name of *monia*) is a pale brown earth easily soluble in acids, less basic than yttria but more so than most earths of the terbia group, and distinctive in many characters. Taking its formula as Vc_2O_3, *victorium* will be about 117. The phosphorescent spectrum of the anhydrous sulphate shows a pair of strong lines at λ 3120 and 3117, and weaker ones at 3219, 3064, and 3060. The form of spectroscope used is described and illustrated. S. R.

1738. *Solution of Gases in Liquids.* **C. Bohr.** (Wied. Annalen, 68. 3. pp. 500–525, July, 1899.)—In order to find a simple relation between the temperature and the absorption of a gas in a liquid, the author breaks up the absorption coefficient into an "invasion" and an "evasion" coefficient, governing the entrance of the gas into the liquid and its exit respectively. The invasion coefficient is the product of the absorption coefficient into the evasion coefficient. It is constant for most liquids between 5° and 20°, but theoretically proportional to the square root of the absolute temperature. E. E. F.

1739. *Action of Gases on Caoutchouc.* **D'Arsonval.** (Comptes Rendus, 128. pp. 1545–1546, June 26, 1899.)—Pieces of indiarubber tubing exposed to gaseous carbonic anhydride under pressures of 1 to 50 atmos. increase in volume considerably and absorb large quantities of the gas. When exposed to the air the rubber returns in about an hour to its original state. Carbonic anhydride passes very rapidly through an ordinary pneumatic tyre inflated with it. When the tyre was inflated with air it slowly became deflated. This deflation ceases after a time, however, if the pressure is maintained constant by pumping in fresh air. The tyre is then found to contain almost pure nitrogen, owing to the fact that oxygen passes through india-rubber much more readily than nitrogen. T. E.

1740. *Pseudo-Precipitation.* **J. Stark.** (Wied. Annalen, 68. 1. pp. 117–124, 1899.)—If an aqueous salt solution is added to water containing fine particles in suspension, the latter are deposited as a rule more rapidly than otherwise, thus giving the appearance of a chemical precipitation. The precipitate is also as a rule flaky. Various explanations, based upon surface tension, cohesion, viscosity, and concentration, have been given of the phenomenon. The author points out the instances in which these explanations fail, and puts forward a view based upon the super-saturation of the liquid with air, which is deposited on the particles. The latter, therefore, have a function analogous to that in the formation of clouds. River-mouth deposits are due to pseudo-precipitation. E. E. F.

1741. *Coagulation of Colloid Solutions.* **J. Stark.** (Wied. Annalen, 68. 3. pp. 618–619, July, 1899.)—The theory advanced by Barus for explaining the formation of flakes in liquids holding coarse particles in suspension does not apply to precipitations of colloids. Colloid solutions are not solutions properly so called, but consist of matter in suspension. This is certainly the case with colloidal, metallic, and sulphide solutions. When a gold sulphide solution is precipitated by zinc chloride the flakes show countless air-bubbles, and when brought under an air-pump they rise to the surface and give off a good deal of air. E. E. F.

1742. *Solution Theory of Iron and Steel.* **H. J. von Jonstorff.** (Indus. and Iron, 26. pp. 425–427, June 2nd; 442–443, June 9th; 463–464, June 16th; 486–488, June 23, 1899.)—The author further develops his calculations (see 1899, Abstract No. 848) of the molecular weights of carbon, of carbides, silicides and phosphides of iron, of nickel, &c., when dissolved in liquid or solid iron, and finds evidence of a series of molecules whose complexity decreases as the temperature rises. The chemical behaviour of steel and iron, especially towards nitric acid in the colorimetric determination of carbon, is considered at length in connection with the results obtained.

As in the previous paper, the experimental data appear to be insufficiently precise to afford reliable results. T. E.

1743. *Theory of Lead Accumulators.* **K. Elbs.** (Zeitschr. Elektrochem. 6. pp. 46–52, July 13, 1899.)—The author maintains that the production of lead peroxide in the charging of an accumulator is due to hydrolytic decomposition of lead bisulphate, $Pb(SO_4)_2$, and not, as Liebenow supposes, to the direct discharge of PbO_2 ions. The first view involves, it is true, an irreversible loss of energy, but this is probably small in amount, and Dolezalek's experiments (see 1898, Abstract No. 689) are not considered sufficiently accurate to disprove the occurrence of such a loss. In support of his view the author urges that the existence of PbO_2 ions has only been demonstrated in the case of alkaline solutions, and that it is very improbable that they exist in acid solutions, whereas various salts of tetravalent lead are known to be more or less readily decomposed by water with formation of lead peroxide. Moreover, the fact that peroxides of zinc and copper are not deposited from alkaline solutions of these metals, although ZnO_2 and CuO_2 ions are evidently present, is in harmony with the author's theory, since zinc and copper, unlike lead, are incapable of becoming tetravalent and forming salts analogous to $Pb(SO_4)_2$.

In the discussion that followed, **Nernst** considered that the decomposition of unstable compounds such as lead bisulphate would necessarily involve the loss of an amount of energy quite irreconcilable with the results of Dolezalek's experiments. The existence of PbO_2 ions in acid solutions in small number was quite conceivable, and was all that was required for Liebenow's theory. **Le Blanc** was of the opinion that several processes, and not one alone, were concerned in the charging of accumulators. **W. Ostwald** expressed his agreement with Le Blanc's views, and pointed out that the hydrolytic decomposition of lead bisulphate was a reversible reaction. N. L.

1744. *Electromotive Behaviour of Chromium.* **Hittorf.** (Zeitschr. Elektrochem. 6. pp. 6–10, July 6, 1899.)—Further observations tend to show that the peculiar variation of the electromotive behaviour of chromium with its chemical state cannot be attributed to the formation of a thin layer of oxide on the surface of the metal. Mainly of chemical interest. (See also 1898, Abstract No. 1072.) N. L.

1745. *Zinc and Cadmium Amalgams.* **T. W. Richards** and **G. N. Lewis.** (Amer. Acad. Proc. 34. pp. 87–99, 1898.)—Some electrochemical and thermochemical relations of zinc and cadmium amalgams were studied by determining the electromotive forces at varying temperatures of the following classes of cells: (1) electrodes of cadmium amalgam of different concentrations; (2) electrodes of zinc amalgam of different concentrations; (3) Solid cadmium electrode opposed to cadmium amalgam; (4) Solid zinc electrode opposed to zinc amalgam.

The main conclusions arrived at are as follow:—

1. A convenient method of measuring E.M.F. directly to a high degree of accuracy is described.
2. Cadmium amalgams as far as concentrations of 3 per cent., and zinc amalgams to concentrations of at least 1 per cent. obey closely the laws of dilute solution.
3. The use of the Helmholtz equation for the temperature coefficient of a cell offers in these cases an accurate method of determining thermal quantities.
4. The heat of amalgamation of cadmium is thus found to be + 505 gramme calories.
5. That of zinc as thus found is − 2255 gramme calories.
6. A solid electrode composed of finely divided electrolysed metal gives a very constant and reliable potential.
7. In the case of cadmium, the contact-potential given by the saturated amalgam in reversible relation to an electrolyte differs by the twentieth of a volt from that given by the metal.
8. In the case of zinc this difference is very slight. J. J. S.

1746. *Vapour-pressure of Solutions.* **R. A. Lehfeldt.** (Phil. Mag. 48. pp. 215–217, August, 1899.)—Nernst's relation between the vapour-pressures of a solvent when pure and when dissolving a small amount of solute, viz., that they are in the ratio of the molecular fractional amounts of the solvent in the liquid and vapour respectively, is tested by measurements on mixtures detailed in another paper (see 1899, Abstract No. 61). The relation is satisfied by carbon tetrachloride and either toluene or benzene, but not by alcohol with either of these liquids.

R. E. B.

1747. *Cryoscopic Behaviour of Alcohols.* **W. Biltz.** (Zeitschr. Phys. Chem. 29. pp. 249–265, June, 1899. Compare Zeitschr. Phys. Chem. 27. p. 529, 1898).—The author has determined the molecular weight of a large number of alcohols from the freezing-point of solutions in benzene of varying concentrations. In all cases a rise of molecular weight occurs as the concentration increases. The results have been plotted in the form of curves. Among the primary alcohols the deviations are greatest for the lower homologues, but in solutions of equal concentrations they are nearly the same for all the higher members of the series. On comparing isomeric alcohols the primary members of the series show greater deviations than the secondary and tertiary; this difference is especially marked where the molecular weight is large and may serve as an indication of the group to which an alcohol of unknown constitution should be assigned.

The results obtained are in accordance with those of Ramsay and Shields (Zeit. Phys. Chem. 12. 468, 1893), on the molecular weight of liquids, and of Traube (Ber. 29. 1027, 1896) on the covolumes of the alcohols. T. M. L.

1748. *Electro-Deposition of Brass.* **T. J. Baker** and **T. J. Baker, Jr.** (Chem. News, 80. p. 37, July 28, 1899).—The precipitate, produced by adding KCN to a cold solution of $CuSO_4$, is regarded as cupric cyanide, which, on boiling, passes into cuprous cyanide by losing $(CN)_2$. Both compounds are soluble in KCN, and these solutions are used for the electro-deposition of copper and of brass. The brass solutions deposit more metal than a copper sulphate bath, placed in series with them. The authors electrolysed the cyanides of copper and zinc, and their mixtures, with a kathode of platinum, fitted over a glass tube, and a concentric anode cylinder. They conclude that the cyanide always deposits the copper in the cuprous state. There are notable differences, however, between their calculated and observed values, which they attribute to the solvent action exercised by KCN on copper and on zinc. H. B.

1749. *Electrodeposition of Palladium.* **S. Cowper-Coles.** (Chem. News, 79. p. 280, June 16, 1899.)—A thin layer of palladium—70 to 80 grains per square foot—is found to form a good protective and reflecting surface for parabolic reflectors. The metal is deposited quite bright from a dilute solution of palladium ammonium chloride, operating at a temperature of 75° F. with a current density of 0·12 ampere per square foot, the E.M.F. at the terminals of the bath being 4–5 volts. The anode may be either palladium foil or carbon. N. L.

1750. *Electrolytic Estimation of Zinc.* **H. Paweck.** (Zeitschr. Elektrochem. 5. pp. 221–224, 1898.)—This paper describes a number of experiments made with the object of overcoming the disadvantages attending the usual methods for the electrolytic estimation of zinc. The chief improvement suggested consists in the use, for the kathode, of a disc of brass wire net, 6 cm. in diameter, the meshes of the net having an area of about 1 sq. mm. Upon this the metal is deposited, either from an alkaline solution containing caustic potash or soda and Rochelle salt, or from an acid solution to which sodium or potassium sulphate is also added. In the former case the brass net is previously amalgamated. Both methods give accurate results. N. L.

1751. *Electrolytic Analysis.* **G. Arth.** (Écl. Électr. 19. p. 338, June 3, 1899.)—The statements of Avery and Dales as to the impurities contained in iron deposited from oxalic solution, are controverted by H. Verwer and F. Groll (Berich. der deuts. Chem. Gesell. p. 806, 1899) who maintain that iron may be accurately estimated by electrolysis at 50–60° with a current of 0·95–1·1 amperes at 2·5–3·0 volts, the metal thus obtained being found by analysis to be free from carbon and other impurities.

E. F. Smith and D. Wallace (Electrochemische Zeitschrift, p. 167, 1898) reply to the objections raised to their work by Heydenreich and bring forward fresh experimental results to show that uranium may be completely deposited from acetic acid solution by electrolysis at 70° for six hours, with a current $D_{40} = 0{\cdot}18$ ampere at 3 volts. Cadmium in the presence of sodium phosphate and free phosphoric acid may also be accurately estimated, the electrolysis being carried on for seven hours at 50° with a current increasing from D.N = 0·06 ampere at 3 volts to 0·35 ampere at 7 volts. N. L.

1752. *Electrolysis of Hydrochloric Acid.* **Haber** and **Grindberg.** (Zeitschr. Elektrochem. 5. pp. 557–560, June 8, 1899; from Zeit. anorg. Chem. 16. pp. 198–228, 329–361, 438–449, 1898.)—The first part of this paper deals with the electrolysis of hydrochloric acid of various degrees of concentration between platinum electrodes at the ordinary temperature. With the concentrated acid, chlorine is evolved at the anode in theoretical quantity, and the amount decreases on dilution until only a small percentage is formed. Traces of hypochlorous acid are formed in the electrolysis of the dilute acid. Chloric acid, to the extent of one third of the theoretically possible yield, is produced when acid of normal to one-third normal strength is used; it is accompanied by traces of hydrogen peroxide. With very dilute acid, perchloric acid in one-fourth of the theoretical yield is produced. Oxygen is also evolved at the anode, amounting to 40 per cent. in dilute acid. The results obtained are discussed theoretically from the point of view of the ionisation hypothesis.

In the second part of the paper the authors examine the behaviour of the acid when partially neutralised by the addition of bases, and the influence of temperature on the course of electrolysis is studied. The presence of bases, contrary to anticipation, appears to have little influence on the quantity of oxygen obtained from dilute acids. Heating the acid increases the yield of oxygen and decreases that of chloric acid.

The third paper deals with the conditions influencing the corrosive action of the acid on the electrodes. At the ordinary temperature platinum electrodes are unattacked by acid of less than 30 per cent. strength, whereas at the boiling-point some solvent action is observed with 11 per cent. acid. Platin-iridium containing 25 per cent. of iridium is unattacked by the hot, strong acid, and that containing 10 per cent. of iridium is but slightly attacked. During electrolysis the formation of platinum black is observed at the kathode. This is not due to transference from the anode, since the kathode suffers a loss in weight. A similar action is noticed in the case of lead, and it is possible to obtain a spongy lead kathode, although of comparatively small capacity, by the electrolysis of sulphuric acid between lead electrodes.

N. L.

1753. *Electrolysis of Benzoic Acid.* **C. Schall.** (Zeitschr. Elektrochem. 6. pp. 102–103, July 27, 1899.)—Electrolysis of a solution of sodium benzoate in fused benzoic acid, using an E.M.F. of 100 volts, results in the production of small quantities of diphenyl and other hydrocarbons. N. L.

1754. *Electrolytic Generators and their Work.* (Elect. World and Engineer, 33. pp. 817–819, June 10, 1899.)—This is a well-illustrated description of the electric generating plant in use at the Boston and Montana Copper and Silver Mining Co., Great Falls, Montana. There is, too, a short outline of the principles of electrolytic copper refining. The plant consists of a twin water-wheel, supplied by the Drayton Globe Iron Works, developing 2,900 H.P., at 130 revs. per minute. This is directly connected to two Westinghouse generators of nominally 810 kw. power, but guaranteed up to 1,210 kw. The brush mechanism and switchboard arrangements are also noticed. There is, finally, a list of the electrical machinery in use for copper refining at the Anaconda Copper Mining Co. of Montana. J. L. F. V.

1755. *Sterilisation of Water by Ozone.* **J. Blondin.** (Écl. Électr. 20. pp. 127–131, July 29, 1899.)—Since 1891, the sterilisation of water by means of ozone has been the subject of numberless investigations. The author refers to some of the earlier of these, and then passes on to a description of the apparatus designed by Marmier and Abraham, and of the results obtained by them at Lille in 1898–99. The installation comprises an alternating current generator, a transformer giving 30,000 volts at the terminals of the secondary, a plate ozoniser and an absorbing tower. The special form of ozoniser used has each of the metallic electrodes enclosed between two glass plates. The electrodes are kept cool by means of water. The absorbing tower is built of masonry.

Tables are given showing the chemical and bacterial character of the water before and after treatment with ozone. The ozonised air passed into the absorbing tower contained between 5·8 m. grs. and 9·5 m. grs. ozone per litre. The organic matter was reduced from ·014 grm. per litre to ·003 grm. per litre, and the bacteria in several instances were completely destroyed, while in other cases they were greatly reduced in number and activity. It was noticed that the results were best when the bacterial examination of the water did not *immediately follow* the treatment in the ozonising tower.

The report of the Commission appointed by the Municipal Council of Lille to examine the apparatus and process is given as a note to the article. This report is favourable to the method, and recommends the adoption of the Marmier and Abraham sterilising process at Lille, where the present water supply is contaminated, and typhoid fever is prevalent.

The author in conclusion discusses the question of cost, and expresses his regret that Marmier and Abraham have not supplied the necessary data to enable this to be accurately fixed. He refers to Andreoli's claim (see Abstract No. 1756) to have designed an ozoniser giving more economical results than the form used at Lille, but points out that in the absence of more complete data it is impossible to compare the results obtained by the two forms of ozoniser and systems of treatment. J. B. C. K.

1756. *Sterilising Water by Ozone.* **E. Andreoli.** (Elect. Rev. 44. pp. 749-750, 1899.)—The author refers to a report by certain French doctors upon the experiments carried out by Marmier and Abraham at Lille relating to the sterilisation of water by ozone. After criticising the form of ozoniser used, he quotes several passages of this report, in which the efficiency of ozone as a germicide is proved.

The author next discusses the question of cost, and states his opinion that the 2 centimes per cubic metre, given by Marmier in an earlier paper, is too high. In order to throw further light upon this question Andreoli has himself recently carried out experiments in London, and has measured the consumption of ozone in terms of electrical energy. The experimental plant consisted of a small Andreoli ozoniser worked at a tension of 3,500 volts, a Roots blower for forcing the ozonised air through the water, and five tanks in which the absorption of ozone by the water occurred. The plant permitted the treatment of 440 gallons water per hour. A table is given showing the effects obtained, with expenditures of electrical energy, varying from 138 to 316 watts per cubic metre (220 gallons) of water.

The author concludes from his experiments upon Thames water that complete sterilisation of water drawn from the river at specially selected spots could be obtained, with an expenditure of electrical energy equal to 100 watt-hours per cubic metre of water.

J. B. C. K.

1757. *Electrolytic Zinc Extraction.* **J. B. C. Kershaw.** (Elect. Rev. 45. pp. 36–37, July 7, and p. 43, July 14, 1899.)—This is a full account of the various processes which have been tried for the electrolytic extraction of zinc from poor or refractory ores.

The Ashcroft process is first dealt with, and the chief causes of its failure are explained, one of the foremost being the falling off of the metallic contents of the ore to be treated. The extraction of zinc from zinciferous pyrites formed the main object of the Dieffenbach process, some time in industrial operations at Duisburg, in Germany, but according to various accounts the cost of extraction of zinc is twice that of the ordinary methods in use. Further mention is made of the Siemens and Halske process which was to be tried at Lake Illawara, N.S.W., and also the Nahnsen process some time at work at Lipine, Silesia, but financial failures have to be recorded of both methods. The Höpfner process, which has been taken up by Brunner, Mond and Co., employs revolving kathodes, and is said to have yielded 400 tons of zinc in 1897. Zinc and other chlorides form the electrolyte, and the simultaneous production of chlorine is also aimed at. Rotating zinc or aluminium kathodes are likewise employed in the Cowper-Coles process, which has been tried both in England and in N.S.W. with a negative result. At St. Petersburg 714 tons of zinc are said to have been produced by the Hernek process, according to a general account without details by Dr. Rostin. A dry process which differs from all preceding ones is the Swinburne method, in which the ore is fused with certain salts which act as a solvent, the various metals being separated by the current.

The author arrives at the conclusion that wet zinc extraction processes are only feasible in exceptional cases, and that further developments will lie more in the direction of dry or fusion methods.

O. J. S.

1758. *Electrolytic Soda and Bleach by Solway Process.* **G. H. Robertson.** (Electrician, 43. p. 226, June 9, 1899.)—This process is a combination of the mercury and gravity processes. Advantage is taken of the fact that the amalgam of sodium and mercury is lighter than the latter metal, and floats upon it. A sill or weir at one end of the cell retains the unamalgamated mercury, and by the continuous circulation of the metal the amalgam is carried over this weir into a separate vessel, where it is decomposed.

The solution used in the cell is not homogeneous, but is composed of two layers. The lower one is in contact with the mercury, and is a nearly saturated solution of common salt. The upper one contains the anodes, and is a less concentrated solution of the same chemical compound. As no gas is liberated in the lower layer, no difficulty is experienced in maintaining each layer intact. The lower layer thus acts as a diaphragm, and prevents the free chlorine, with which the upper layer of the electrolyte is saturated, from attacking the mercury at the bottom of the cell. Both solutions are regenerated by circulating them through the cell horizontally in the same direction as the mercury.

J. B. C. K.

1759. *Treatment of Gold-Silver Alloys.* **A. Dietzel.** (Zeitschr. Elektrochem. 6. pp. 81–85, July 27, 1899.)—The simplest electrolytic method for treatment of these alloys is to use the alloy as anode in an electrolyte of acidified silver nitrate solution. The silver passes into solution and is redeposited at the kathode, while the gold remains insoluble. The procedure is unsatisfactory when other metals are present as impurities, for part of the acid anion's arriving at the surface of the anode attack and dissolve these impurities, and the composition of the electrolyte thus undergoes gradual change. When copper is present there is also the danger that it may be deposited with the silver at the kathode. This is especially the case with poor gold-silver alloys which always contain considerable amounts of copper. For such alloys the author recommends a method of procedure which has been in successful operation for six years at the "Gold and Silver Scheide Anstalt," at Pforzheim.

The alloys used at this factory are cuttings from various sources, and they average 5–7 per cent. gold, 22–50 per cent. silver, 40–65 per cent. copper, 5 per cent. zinc, tin, and lead; traces of cadmium, iron, nickel, and platinum are also present. The amount reworked daily is about 60 kgs. A copper nitrate solution is used as the electrolyte. The copper and silver pass into solution. The copper is deposited electrolytically; the silver is removed at a later stage *outside the depositing bath* by chemical means. The method is thus a reversal of the usual procedure. The apparatus used at Pforzheim is described and illustrated.

The electrolyte requires to be maintained acid by additions of nitric acid. The removal of the silver is effected in special cylinders filled with scrap copper, which displaces the silver by simple chemical substitution. The silver in solution can be reduced to 0·03 per cent. by this means. Arrangements for the removal of the iron by aëration and filtration are also made.

The insoluble sludge contains gold, silver, copper, tin, and lead, and is treated by chemical methods for the recovery of the gold. The value of the copper deposited in the electrolytic vat under favourable working conditions covers the whole cost of the process. Zinc and cadmium when present pass into solution with the copper and silver, and as these two impurities cannot be removed economically, the electrolyte in time becomes surcharged with impurities and has to be discarded. J. B. C. K.

1760. *Electrolytic Chlorate Works at Chedde, Savoy.* **J. B. C. Kershaw.** (Elect. Rev. N.Y. 35. pp. 8–9, July 5, 1899.)—The process, at work in the factory built by the *Société des Forces Motives de l'Arve,* is that patented by P. Corbin. The works themselves are situated at Chedde Haute Savoie, close to Mont Blanc. The total length of pipe line and tunnel between the dam of the river and the turbines at the works is 1,790 metres. The total available power is 12,000 HP., and to utilise this there are twelve vertical turbines of 1,000 HP., each direct coupled to an Oerlikon dynamo of 830 units. The cells employed according to the Corbin patents are built of cement, and the electrolysis is conducted by means of a number of secondary platinum foil electrodes, insulated from one another in ebonite frames. The current is only introduced at the extreme ends. Reference is made to recent investigations into the chemistry of the Electrolytic Chlorate process, the work of Oettel being specially noted. The author finally enters into the question of the cost of production of the chlorate by the electrolytic method and calculates the price to be 5·59 cents per pound, on an output of 800 tons per annum. J. L. F. V.

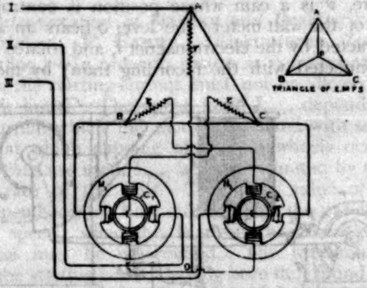
GENERAL ELECTRICAL ENGINEERING.

1761. *Accumulators for Automobiles.* **M. L. Inman.** (Elect. Rev. 45. pp. 119–120, July 21, 1899.)—This article, which is taken from the Revue de Physique et Chimie, gives particulars of the construction of various French makes of storage cells in present use, and more especially intended for traction purposes. Useful figures relative to the electrical capabilities of each type are also supplied. E. J. W.

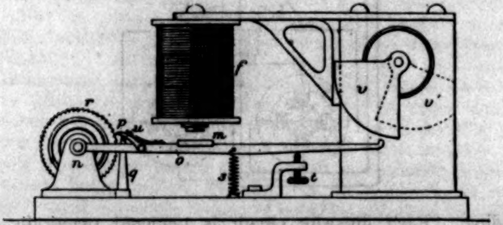
1762. *New Method of Accumulator Construction.* **A. Tribelhorn.** (Elektrotechn. Ztschr. 20. p. 336, 1899.)—The method resembles that used in the original Volta pile, the cells being piled one above the other instead of being contained in separate glass boxes as is now usual. The battery consists of a series of shallow rectangular lead vessels with sloping sides, placed one above the other, with spherical insulators in the four corners of each vessel to prevent metallic contact. The bottom of each vessel is corrugated, the number of corrugations depending on the number of plates to be used in each cell. From the crests of the corrugations project inwards the negative plates, while the positive plates are suspended from the lower or outer face of the corrugated bottom. When the vessels are in position the downwardly projecting positives of any cell come between the upwardly projecting negatives of the vessel immediately below it. The vessels being shallow, the depth of the electrodes is comparatively small, hence the danger of buckling and short-circuiting is greatly reduced, and the fact that the cells cannot be readily inspected is not a serious disadvantage. The main advantages claimed by the author are: (1) a saving of floor space amounting to as much as 75 per cent. over the ordinary method; (2) there are no joints to be made between the terminals of consecutive cells; (3) absence of special containing vessels or boxes for the plates and acid, and better insulation. A. H.

1763. *Safety Devices in Electrical Distribution.* **W. L. R. Emmet.** (West. Electn. 24. pp. 312–313, June 3, 1899. Paper read before the National Electric Light Association, at New York, May 23–25, 1899.)—The author discusses the chief sources of danger and the corresponding safeguards in electrical distribution, with special reference to earth connections, accidental and precautionary. Drawings are given of fusible and other cut-outs intended for breaking heavy currents at extra high pressures with safety. A. H. A.

1764. *Three-Phase Energy Meters.* (Elekt. Runds. 16. pp. 152–154, 1899.)—These meters, recently patented by Siemens and Halske, are of the induction motor type. The principle of construction will be understood from the accompanying figure, which shows the method of connection to a three-phase network. The meter consists essentially of two coupled two-phase induction motors, M_1 and M_2. Each motor has a stator consisting of a hollow laminated cylindrical mass of soft iron furnished with four inwardly projecting pole-pieces, and a central laminated cylinder placed between the pole-pieces. The rotor is a hollow cylinder (C_1 and C_2 in the sketch) of copper or other metal. One pair of diametrically opposite pole-pieces in each stator is provided with a thick-wire or series winding, the other with a fine-wire or shunt winding. Each fine-wire circuit is rendered practically non-inductive by connecting in series with it a sufficiently high non-inductive resistance (r_1 and r_2 in the sketch). The series windings are inserted into the mains II, III, while the main I is connected direct to the point A of the three-phase load A B C. If for a moment we suppose that M_1 and M_2 are two watt-meters, then in order to measure the power it would be necessary to connect the shunt circuit of M_1 between B and A and that of M_2 between C and A—this being the ordinary two watt-meter method of power measurement. But, since we are dealing with induction motors, the E.M.Fs. between B and A, and C and A, must be replaced by others which are exactly in quadrature with them, in order that the necessary rotating field may be produced. Such E.M.Fs. may be obtained by arranging the connections as shown in the sketch, the resistance r being equal to the total resistance of the shunt circuit of either motor. From the subjoined triangle of E.M.Fs. it is evident that the E.M.F. CO, which acts on the shunt circuit of M_{11}, is in quadrature with AB, and that similarly BO is in quadrature with CA. A. H.



1765. *Routin's and other Systems of Charging for Electrical Energy.* **E. Hospitalier.** (Ind. Élect. 8. pp. 233–237, June 10, 1899.)—The author applies the laws of supply and demand to show that a fixed rate of charge is wrong in principle, and that the charge should vary in accordance with the demand at any instant. He then reviews all the better-known systems of charging, pointing out their defects, and selects the automatic two-rate meter and the variable charge system of C. E. L. Brown and J. L. Routin as the most approximate solutions of the problem. The former is too complicated, and is limited to two rates; the latter is put forward as the most satisfactory. The system consists of an intermittently integrating watt-meter or ampere-meter, the frequency of integration of which is controlled from the generating station, and varied according to the demand. In the figure, *v* is a cam whose position is controlled by the mechanism of the watt-meter; the lever *o* bears an armature *m* which is attracted by the electromagnet *f*, and rotates the ratchet-wheel *r* (connected with the recording train) by means of the pawl *p* round the axis *n* through an angle proportional to the power passing, its range being dependent upon the position of the cam *v*. The lever is restored by the spring *s* to its initial position, which is adjusted by the screw *c*. The conical screw *u* provides an additional adjustment for the pawl. The whole of the meters on consumers' premises are controlled by a master-clock at the generating station, which actuates the electromagnets by momentary currents; the frequency of these currents is regulated to suit the demand, either in steps or by a gradual variation. To avoid the necessity of special wires, when the supply is on the direct-current system, alternating currents are periodically transmitted to the meters, using one of the line conductors with earth return through a condenser; while, if an alternate current supply is used, direct currents are transmitted, the condenser being omitted and the inductance of the electromagnets being made so great as to choke back the alternating currents. A special wire is, however, necessary if a high pressure system with isolated transformers is used. The advantages claimed for the system are: simplicity, complete control of the variable rate of charging, absence of auxiliary wires, direct



indication of the sum payable, and small consumption of power in the meters. The system is no bar to the installation of numerous and varied apparatus, while it affords the most rational and just means of charging for energy. A. H. A.

1766. *Ampere-Hour Meter without Jewels.* **W. D. White.** (Elect. World and Engineer 33. pp. 855–856, June 17, 1899.)—W. Stanley suspends the aluminium brake disk by the magnetic attraction of the permanent field magnets. The instrument can be used as calibrated in the factory and travels without any part requiring to be clamped. M. O'G.

1767. *Determination of Starting and Braking Resistances for Traction Motors.* **F. Erens.** (Elektrotechn. Ztschr. 20. pp. 277–282, 1899.)—In order to secure as constant an acceleration as possible, the starting-current must not be allowed to vary outside certain limits. The upper limit, $I_{max.}$, depends (1) on the greatest current which the motor can stand with safety; (2) on the point at which slipping of the car wheels occurs. Where secondary cells are used, $I_{max.}$ is further limited by the maximum discharge rate of the cells. The mean value of the starting current depends on the time during which the car is required to attain full speed; when this is given, the corresponding torque and current may be determined. The maximum and mean values of the starting current having been thus found, its minimum value, $I_{min.}$, is also fixed. The value of $I_{min.}$ is, however, further restricted by the fact that if the difference $I_{max.} - I_{min.}$ be made very small, a very large number of contacts will be required in the controller; if the number of contracts is fixed, as well as $I_{max.}$, then $I_{min.}$ is (as will be evident from what follows) also fixed. The counter-E.M.F. e of the motor is a function of the car speed and the current, so that $e = ksm$, where k is a constant depending on the gearing and wheel diameter, s is the speed of the car, and m a factor whose value depends on the current. If V be the working P.D. of the line, and R the total resistance in the motor circuit, the corresponding current is given by—

$$I = \frac{V - ksm}{R} \quad . \quad . \quad . \qquad (1)$$

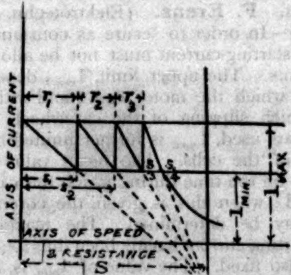
Let m_0 and m^1 be the values of m corresponding to $I_{max.}$ and $I_{min.}$ respectively; further, let $\alpha = I_{min.}/I_{max.}$, and $\beta = m^0/m^1$. Then, by successive application of the fundamental equation (1), the author shows that, if s_1, s_2, . . . stand for the speeds attained by the car as the controller-handle passes over the successive contacts,

$$s_2 - s_1 = \alpha\beta s_1\,;\ s_3 - s_2 = (\alpha\beta)^2 s_1\,;\ s_4 - s_3 = (\alpha\beta)^3 s_1,\ \&c. \quad . \quad . \quad . \qquad (2)$$

Also, if r_1, r_2, r_3, . . . stand for the consecutive resistances which are cut out as the controller-handle is turned, then

$$r_2 = \alpha\beta r_1 \, ; \; r_3 = (\alpha\beta)^2 r_1 \, ; \; r_4 = (\alpha\beta)^3 r_1, \text{ \&c.} \; . \; . \; . \qquad (3)$$

Since equations (2) and (3) are of the same form, it follows that if in a graphical construction s_1, $s_2 - s_1$, $s_3 - s_2$, . . . be represented by certain lines, these lines will also, to a different scale, represent r_1, r_2, . . . The graphical construction given by the author is shown in the accompanying figure, in which S stands for the sum to infinity of $s_1 + \alpha\beta s_1 + (\alpha\beta)^2 s_1 +$ . . . and denotes the theoretical speed which would be reached with a current $I_{min.}$ if the controller were furnished with an infinite number of contacts and the resistance of the motor were negligible.



The author next extends his analytical investigation and graphical construction to the case of a shunt-wound motor, and to the determination of the resistances to be inserted into the motor circuit when utilising its generator action for braking purposes.

A. H.

1768. *Aluminium Conductors.* **J. B. C. Kershaw.** (Lightning, 16. pp. 27–28, 143–144, 1899.)—Notes upon the practical applications of aluminium as an electrical conductor. (See 1899, Abstract No. 164.)

EDITOR.

1769. *Mechanical Applications of Electricity.* **G. Richard.** (Écl. Électr. 19. pp. 481–489, July 1, 1899, 20. pp. 81–89, July 22nd.)—Descriptions of mechanical appliances including Tesla's marine mechanisms controlled by waves, Eickemeyer pump, various weighing machines, clocks and fans.

EDITOR.

1770. *Electric Motor Semaphore.* **F. Křižik.** (Zeitschr. Elektrotechn. Wien, 17. pp. 392–398, July 16, 1899.)—It is proposed to work railway signals and other semaphores by means of electromotors. The arm of each semaphore is to be connected through a system of levers to an eccentric gear actuated by an electromotor. Diagrams are given showing the electrical connections necessary for a "block" signal arrangement. The method has only been tried in the form of a model. R. A.

1771. *Electric Power for Marine Propulsion.* **C. T. Child.** (Eng. Mag. 17. pp. 477–482, June, 1899.)—The author points out that, except in the case of canal boats, the electric propulsion of vessels must be by means of secondary batteries, and briefly discusses their characteristics. The great weight and small capacity of accumulators are far less detrimental afloat than in vehicles on roads; under the best conditions—when the battery is discharged in one hour—the weight of an electrical equipment is about 234 lb. per H.P., as compared with 57·5 lb. in the case of a steam outfit. The author considers that a frequent service of ferry-boats, for example, equipped with electrical machinery, and charged from a shore-station each trip, would show a high efficiency combined with other advantages. Torpedo boats are also instanced as peculiarly suited to electric propulsion; such a boat could attain a speed of 22 knots for one hour, or 12 knots for twenty-four hours with the same battery. A. H. A.

1772. *Electric Pumping in Mines.* (Elect. Rev. 44. pp. 939–941, June 9, 1899.)—This paper consists, principally, of a description of some of the electrical pumps supplied by Messrs. Scott & Mountain; *e.g.*, a combined centrifugal pump and motor, and a combination of triple-pump and electric-motor designed to run in any position where there is much dust or dirt. In the latter combination the motors develop about 2 H.P. each and run at 1,223 revs. per minute, the power being transmitted to the pumps by means of spur and worm gearing, the steel worm revolving in an oil-bath. A. S.

1773. *Condensers for Electric Light and Power Stations.* **J. F. C. Snell.** (Electrician, 43. pp. 406–408, July 14, 1899. Discussion, pp. 408–409. A paper read before the Municipal Electrical Association, June 16, 1899.)—Surface condensers, ejector condensers and evaporative condensers are discussed with special reference to the working conditions. A discussion followed. A. S.

GENERATORS, MOTORS, AND TRANSFORMERS.

1774. *Synchronisers for Three-Phase Generators.* **H. Müller.** (Elektrotechn. Ztschr. 20. pp. 416–417, June 15, 1899.)—Several devices are described capable, not only of indicating when the alternators are in phase, but also of showing whether the incoming machine has to be accelerated or retarded in order to run synchronously. The first device consists of two simple laminated rings, one within the other, the outer being fixed and the inner free to rotate, and carrying an index. Both rings are provided with an ordinary Gramme winding; three points 120° apart in the winding of the outer ring are connected to the three-phase 'bus bars, and the winding of the inner ring is similarly connected to the terminals of the incoming machine. The connections are so arranged that the rotating fields in the two rings have the *same* direction of rotation. It is obvious that if the incoming machine is running synchronously and co-phasally, no torque will be exerted on the movable ring, which will also occupy a perfectly definite position (the index being vertical). But if the machine is either fast or slow, there will be relative rotation of the two fields, which will be rendered visible by a rotation of the inner ring. The main switch is closed at the instant when the index slowly passes through the vertical position. In another device, somewhat simpler in construction, a single fixed laminated ring provided with three independent closed windings is used. The first winding is connected to the 'bus bars, the second to the terminals of the incoming machine, and the third supplies a number of incandescent lamps arranged in a circle, diametrically opposite lamps being joined in series with each other and connected to diametrically opposite points in the winding. The fields due to the first and second windings are arranged to rotate oppositely. If the incoming machine runs synchronously, a simple alternating field will be produced in the ring, and in the circle of lamps there will be one pair (diametrically opposite) at maximum brilliancy, the brilliancy of the others falling off round the circle until complete darkness is reached along the extremities of a perpendicular diameter. If further the machine runs co-phasally, the diameter of maximum brightness occupies a perfectly definite (vertical) position. Want of synchronism, and the direction in which the speed should be varied, are indicated by an advancing wave of light in the circle of lamps.

[*Cf.* Abstract No. 892, 1899. The arrangement described above has been used for a number of years by L. Schüler; see Elektrotechn. Ztschr. 20. p. 523, 1899.] A. H.

1775. *Friction Losses in Dynamos.* **G. Dettmar.** (Elektrotechn. Ztschr. 20. pp. 380–383, June 1, and 397–400, June 8, 1899.)—The author's experimental investigations lead to the following important results: 1. When the bearings are maintained at a constant temperature, the coefficient of friction increases as the square root of the speed, so that the *power lost by friction increases as the* 1·5*th power of the speed.* 2. The bearings being maintained at a constant temperature, and the speed remaining constant, the coefficient of friction varies inversely as the pressure per sq. inch of the bearings, so that *the power lost by friction is independent of the pressure on the bearings*, provided the latter does not exceed 30 to 44 (depending on lubricant) kg. per sq. cm. (426 to 624 lb. per sq. inch), which is well outside the limits of good practice. 3. The pressure on the bearings and the speed being constant, the coefficient of friction, and *power lost by friction, vary inversely as the temperature* (in degrees C.; between limits of 15° and 50° C.). Results 1 and 2 are also borne out by some experiments on friction carried out by Tower in 1885 (Ztschr. Ver. Deutsch. Ing. pp. 839–840). The author arrived at result 1 by experimenting on a countershaft supported by three bearings and carrying no pulleys, but only a speed cone whose greatest diameter did not exceed 29·5 cm. With such an arrangement, windage is negligible in comparison with bearing friction; and since result 1 was found to hold for this case, it follows that the increase in the frictional resisting torque with increase of speed is, in the case of dynamos, to be ascribed to a true increase in the coefficient of friction, and not, as one might at first feel inclined to suppose, to increased air resistance. The countershaft experimented on was run up to the desired speed by means of an electromotor which was directly coupled to it, and the method of ascertaining the power absorbed by the shaft at different speeds consisted of a combination of the method explained in Abstract No. 199 (1898), with that explained in Abstract No. 1430 (1899). Some special experiments, carried out by the author with the view of ascertaining the relative amount of frictional loss due to windage, lead to the conclusion that in dynamos with rotating armatures, this loss does not exceed from 7 to 9 per cent. of the total friction loss. The method of experimenting consisted in running a motor carrying a flywheel having a heavy rim supported by arms, first under ordinary conditions, then with a plain cylindrical case slipped over the flywheel, so as to reduce the churning action as much as possible. Result 2 is equivalent to the somewhat startling assertion that the *friction loss remains constant at all loads, and is independent of the tension of the belt.* The truth of this statement is, however, borne out by an experiment in which the frictional losses were determined for a 2 H.P. motor when running with and without a heavy flywheel, whose weight was sufficient to double the pressure on the bearings: absolutely no difference between the friction losses corresponding to the same speed could be detected in the two cases. On the basis of these results, the author establishes some useful formulæ for calculating the frictional loss. The most important of these are given below :—

$$F_1 = 49 r.d.l.v^{1·5} \quad . \; . \; . \quad (I)$$

$$F_2 = \frac{-T + \sqrt{T^2 + 62·4 u.s.v^{1·5}}}{0·637 u} . d.l \quad . \; . \; . \quad (II)$$

In the above, F_1 and F_2 stand for the friction loss in watts; d is the diameter, and l the length of journal, in cm.; v is its peripheral velocity, in *metres per second*; and r, u, and s denote certain constants to be determined for each type of machine. The simpler formula (I) does not, and the more complicated one (II) does, take into account temperature changes. For the machines built by Körting Bros., the author found that the constant r had a value of ·014 at a temperature of 37·5° C.; and the constants u and s values of 25 and 0·53 respectively. In formula (II), T is the temperature of the surroundings, and may be taken to be 20° C. The friction losses calculated by the above formulæ were found to agree very satisfactorily with those determined by experiment. A. H.

1776. *Friction Losses in Dynamos.* **J. Fischer-Hinnen.** (Elektrotechn. Ztschr. 20. pp. 392–393, June 1, 1899.)—The author finds that for carefully constructed machines the coefficient of friction varies between 0·038 and 0·06 with a peripheral velocity of the journal amounting to from 2 to 2·5 metres per second. Dealing next with brush friction, he gives the following formula for the loss in watts W_b due to this cause :—

$$W_b = \frac{2\rho}{S} \cdot \frac{I^2}{p} + 2 \times 9·81 SPfpv.$$

where—

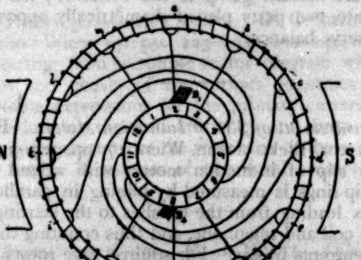
ρ = contact resistivity (= 0·2 for carbon, and 0·02 for metal brushes).
S = brush contact area per rod, in sq. cm.
I = total armature current.
p = number of bifurcations of armature current.
P = brush pressure, in kilogrammes per sq. cm. (= 0·12 to 0·15).
f = coefficient of friction (= 0·3 to 0·4).
v = peripheral velocity of commutator, in metres per second.

By differentiating W_b with respect to S and equating to zero, we obtain S_0, the value of S which gives a minimum value of W_b. We thus get $S_0 = \frac{0·21 I}{p\sqrt{v}}$ for metal brushes, and $S_0 = \frac{0·68 I}{p\sqrt{v}}$ for carbon brushes. In the case of machines of moderate size

(20 to 60 kilowatts) working at 100 to 120 volts and having two to four brushes, it is not always easy to provide the contact area demanded by these formulæ. A. H.

1777. *Improvements in Brush Alternators.* **E. K. Scott.** (Electrician, 43. pp. 595–596, August 18, 1899.)—The paper describes the reconstruction of the brush alternators at Bankside station by Ferranti Ltd. The main improvements consist in using copper strip beaded down the middle for winding the armature coils, whereby side slip is absolutely prevented; in connecting all the coils in series instead of two parallels, thus dispensing with an equaliser, the coils with maximum voltage between them being separated by a dummy coil; and in drilling the pole-pieces and fitting them with external cowls which serve to catch the air and drive it against the armature coils through the perforations in the pole-pieces. A. H.

1778. *Special Types of Alternators.* **F. J. Patten.** (Elect. World and Engineer, 33. pp. 648–649, 1899.)—A brief illustrated description of some methods of obtaining alternating and pulsating unidirectional currents from an ordinary Gramme armature. The arrangement shown in the accompanying sketch is one patented by the author in 1889. The points *m*, *a*, and *b* in the winding are connected to the nearest commutator segments; the next group of points, *c*, *d*, *e*, is in connection with diametrically opposite segments; and so on alternately. Such an arrangement gives two complete waves of alternating current per revolution in an external circuit connected between the brushes B_1 and B_2. A pulsating unidirectional current may be obtained in a circuit by



connecting one of its terminals to one of the ordinary brushes of a simple Gramme armature (with ordinary connections to commutator), and the second terminal to a brush pressing against a slip-ring which is joined to one point in the winding; a single pulsation corresponds in this case to a revolution. By arranging a second circuit between the same ordinary brush and a second slip-ring connected to a point diametrically opposite to the one in connection with the first ring, a pulsating current having the reverse direction will be obtained in the second circuit. A. H.

1779. *Westinghouse Alternators at Madison Electricity Works, N.J.* (Amer. Electn. 11. pp. 257–259, June, 1899.)—A Westinghouse alternator of a new type has lately been installed in this station. The machine is rated at 250 kw. and delivers single phase current at 1,100 volts; the armature winding, instead of being one coil per pole buried in a large slot, as in the usual type, consists of a spiral coil for each pole fitting into eight slots, these slots are almost uniformly spaced round the surface of the armature, the middle tooth of each group being slightly wider than the rest; the coils are kept in position by wooden strips as in the direct current machines of the same company. Another peculiarity is that the armature current itself does not pass through the rectifying commutator and series coils of the field; a series transformer rotates with the armature and supplies the commutator and series field with a derived current proportional to the armature current going to the collector; the transformer is divided into two parts placed diametrically opposite to each other to preserve balance. M. G. W.

1780. *Measurement of Slip of Induction Motors.* **E. Rosenberg.** (Zeitschr. Elektrotechn. Wien, 17. pp. 327–331, June 14, 1899.)—The slip of induction motors with wound rotors connected to slip-rings is measured by joining in parallel with one of the cables leading from the brushes to the starting resistance an induction coil and telephone, and thus counting the frequency of the rotor currents by ear. For squirrel-cage rotors the leakage-field due to the rotor current is employed by means of an induction coil and telephone. The necessary precautions are detailed. To obtain a permanent record of the slip the induced currents are made to actuate the relay of a Morse writing telegraph instrument, and thus a rapidly varying slip up to 20 per cent. can be accurately determined at any instant. A complete investigation made by this method is described. The motor employed was a 3½ HP 42 ∿ four-pole induction motor, and observations were made at various loads as motor, and also when driven at over-synchronous speeds as generator. Some of the results are given in the following table :—

AS MOTOR.

Slip ∿ per min.	Speed Revs. per min.	INPUT.			OUTPUT.		Torque kg. m.	Power factor cos φ.	Effy. per cent.
		Volts.	Amps.	Watts.	H.P.	Watts.			
36	1,282	104	27	870	0·57	420	0·32	·31	48
66	1,267	105	37	2,540	2·53	1,864	1·43	·66	70
86	1,257	104	45	3,380	3·45	2,542	1·98	·73	75
120	1,240	102	56·5	4,400	4·10	3,022	2·37	·77	71
186	1,207	101	68	...	4·55	3,361	2·72	...	...
366	1,117	100	88	...	4·2	3,104	2·72	...	...

AS GENERATOR.

		OUPUT.			INPUT.				
16	1,308	110	27·5	...	1·00	733	0.55	...	...
58	1,329	113·5	41·5	2,360	4·68	3,439	2·52	·50	69
82	1,341	113·5	50	3,240	6·10	4,489	3.27	·57	72
100	1,350	114·5	60	3,990	7·45	5,485	3·96	·58	74

(See also 1899, Abstract No. 1579.)

L. B.

1781. *Theory of Induction Motors.* **G. Ossanna.** (Zeitschr. Elektrotechn. Wien. 17. pp. 223–228, 236–240, and 248–255, 1899.)—Starting from a simple vector diagram which gives the magnitudes and phases of the various quantities involved, the author obtains expressions for the primary current, torque, heat loss in conductors, slip and efficiency, and from them deduces graphical representations of the variations of these quantities with secondary load. A number of numerical examples are worked out.

A. H.

1782. *Transformer Cores.* **E. K. Scott.** (Electrician, 43. p. 192, June 2, 1899.)—The author states that, quite apart from magnetic ageing, the large core loss observable in some types of transformers is due to excessive mechanical pressure on the core plates, which are screwed up very tightly between end plates. He cites a case noticed by Mordey in which a laminated core when subjected to a pressure of 1,500 lb. per square inch gave an increase of 21 per cent. in the core loss (the latter returning to its original value on removal of pressure). In another case, recorded by Parshall, a pressure of 2,200 lb. per square inch on a good sample of transformer iron increased the hysteresis loss by 53 per cent. These experiments appear to show that in building up transformer cores only so much pressure should be exerted on the core plates as is absolutely essential to good mechanical construction. A. H.

1783. *Transformer Core Losses.* **W. E. Goldsborough.** (Elect. World and Engineer, 33. pp. 645–647, 1899.)—Curves and tables are given showing the great progress recently made in transformer construction. In the older types of 125-cycle transformers the average core losses amount to from 1 per cent. to 9·7 per cent. for outputs ranging from 20 kilowatts to 1 kilowatt respectively. In modern transformers of the same frequency and range of output the average core losses vary between the narrow limits of ·8 and 2·6 per cent. The improvement is even more marked in the case of 60-cycle transformers, the corresponding figures being 1·4 to 11·3 per cent. for the older types, and 1·1 to 3 per cent for the modern ones. A. H.

1784. *Transformer Tests.* **W. E. Goldsborough.** (Eng. News, 40. pp. 351–353, June 1, 1899. Also Elect. World and Engineer, 33. pp. 875–876, June 24th. See 1899, Abstract No. 190.)—The following results were obtained with five 5-kilowatt 60-cycle modern transformers by different makers :—

	I.	II.	III.	IV.	V.
Regulation, hot, per cent.	1·74	2·63	2·16	2·32	2·12
Iron loss, full load, per cent.	1·63	1·41	1·76	1·42	1·71
Copper loss (hot), full load, per cent. ...	1·78	2·51	2·07	2·05	2·04
Efficiency, per cent., at ·1 output ...	85·4	87	84·2	87·4	84·7
„ „ „ ·25 „ ...	93·3	93·9	92·7	94·1	92·9
„ „ „ ·5 „ ...	96·0	95·9	95·4	96·2	95·6
„ „ „ ·75 „ ...	96·5	96·2	96·1	96·6	96·2
„ „ „ full output ...	96·6	96·1	96·2	96·6	96·3
„ „ „ 25 % overload ...	96·5	95·7	96·0	96·4	96·2
Temperature above air, full load test, degrees C. ... After 5 hrs.	20·6	20·3	41·7	23·7	39·9
„ 10 „	24·9	27·1	52·1	30·6	49·9

Tests made to determine the ageing of the cores showed that the iron was, in all five transformers, practically of non-ageing quality.

In the discussion on the above paper, **Leslie** stated that his company required a 2 per cent. regulation with a 2 per cent. core loss and an insulation resistance of not less than 2,000 megohms. His experience was that the life of even a modern transformer did not much exceed five years. **Robb** considered that the data given by Goldsborough were applicable to lighting transformers only. A. H.

1785. *Transformer Core Losses.* **G. W. Hubley.** (Elect. Rev. N.Y. 34. p. 382, June 14, 1899. Abstract of a paper read before the National Electric Light Association, N.Y., May 25, 1899.)—The author gives the following table, which relates to transformers of various types of manufacture during the years 1894–96, and which shows the very considerable gradual increase in the core loss :—

Capacity of Transformer, in Kilowatts.		·5	1·0	1·5	2	3	4	5	7·5	10	12·5	25
Core loss in watts	Initial test	36	58	60	75	80	109	120	145	190	218	323
	Second test	65	75	97	125	133	175	140	167	250	238	530
	Third test	75	100	120	145	150	185	145	190	...	315	...

The time of service between tests in the above table varies from six months to two years, but in most cases it is one year. In order to reduce the abnormal core losses exhibited by some transformers, the author has recently adopted the plan of reannealing the core-plates. The effect of this treatment is shown by the following table :—

Capacity of Transformer, in Kilowatts.		·5	1	2	3	7·5	10	25
Core loss in watts	Initial test................	40	60	84	108	140	175	350
	Test before treatment	64	88	150	139	167	240	530
	Test after treatment	42	59	117	97	135	160	323

The author finds that the cost of reannealing is trifling in comparison with the increased economy of working which is thereby secured.

A. H.

1786. *Design of Single-Phase Rectifier.* **J. C. Brocksmith.** (Amer. Electn. 11. pp. 282–285, June, 1899.) — A detailed description, with full working drawings, of a single-phase rectifier, suitable for 50 or 100 volt circuits and a frequency of 60 or 125.

A. H.

1787. *High-Speed Rotary Converters.* **E. K. Scott.** (Electrician, 43. pp. 304–305, June 23, 1899.)—The author gives diagrams showing that the price and weight of continuous current transformers, as at present designed, are respectively five and three times as great as those of alternating current transformers of equal rating, and suggests that they should be run with spindles vertical at about four times the ordinary speed. A cross-sectional elevation of such a transformer is given; it is pointed out that the floor-space occupied is very small, and that the machine could be lowered through a small manhole into an underground substation. To relieve the pressure of the footstep bearing, the armature core may be placed slightly out of centre vertically. The same arguments apply to boosters, balancers, &c. A. H. A.

1788. *Transformation of Three-Phase to Two-Phase Currents.* **P. G. Watmough.** (Elect. World and Engineer, 34. pp. 120–121, July 22, 1899.)—The author explains the principle of this transformation in a very simple manner as follows: Draw three equal vectors, A, B, and C, 120° apart, to represent the three E.M.Fs. of the three-phase supply. Reverse C, and then compound it with B. Increase the length of A in the ratio of 1·73 : 1. Then the resultant of B and C reversed on the one hand, and A lengthened on the other, constitute a pair of equal vectors in quadrature, and thus represent two-phase E.M.Fs. In practice, these changes may be carried out by using two transformers; the primary of the first is supplied with the A – E.M.F.; by using the proper number of turns in the secondary, this E.M.F. may be increased in the required ratio. The second transformer is provided with two primaries, one supplied with the E.M.F. B, the other with the E.M.F. C; reversal of the latter is obtained by reversing the connections of the corresponding primary coil; and compounding of B and C reversed results if a single secondary be provided. The secondaries of the transformers will thus supply two-phase currents. A. H.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

1789. *Distribution by Two-Phase Currents in New York, U.S.A.* **E. A. Leslie.** (West. Electn. 24. pp. 311 and 317, June 3, 1899. Paper read before the National Electric Light Association at New York, May 23–25, 1899.)—A description is given of the methods and apparatus adopted in substituting two-phase for single-phase distribution, in order to supply motors above 5 H.P. On account of want of facilities in the common subways, two separate circuits are used, in quadrature, instead of a common return system. A novel system of regulation, devised by W. F. Wells, is described and illustrated; a third wire is connected with the armature winding of each phase, at a point 10 per cent. from one end, so that there are six 'bus bars in all. Between the two 'bus bars in each phase which thus differ in potential by 10 per cent. of the whole pressure, a "single-wound transformer" is connected for each external circuit; the winding of this is divided into ten parts joined to a regulating switch. The circuit wires are joined, one to the switch and one to the remaining 'bus bar. With this apparatus the pressure can be regulated in steps of 1 per cent. of the total pressure. The system of testing the insulation of the live circuits and of locating faults is described, with diagrams; when overhauling and testing the circuits, the testing galvanometer is fixed in the station, and communication is maintained with the repair gang by means of telephones temporarily connected with the main cables. The system of two-phase distribution used by another New York supply company is also briefly described; in this case the generators and some of the transformers are connected on the "star" system, with three-wire feeders, one of which is smaller than the others and is used for power only. The power required in New York for elevators alone amounts to 15,000 H.P. A. H. A.

1790. *Three-Phase Four-Wire Low-Tension System.* **A. J. Bowie.** (Elect. World and Engineer, 33. pp. 840–842, June 17, 1899.)—The system considered is one in which star-coupled generators supply a four-wire distributing network, the fourth wire being in connection with the neutral point. The P.D. between the neutral and any one of the three "legs" is 115 volts, and is intended for lamps, while that between any two legs is 200 volts, and is intended for motors. The author compares this system with (1) the continuous-current three-wire system; (2) the transformer system. 1. Good balance and large mains are more important with the alternating system, which is likewise harder to balance, as the load must be divided into three parts instead of two. All troubles from inductance and low power-factor are absent with the continuous-current system. Allowing for a high power-factor, the efficiency of the two systems would be about the same. The drop is greater in the alternating system, thus requiring more switchboard attendance. 2. The full-load efficiency will generally be in favour of the transformer system, which also has the advantage that so good a balance is unnecessary, and that a sudden change in the load, even if it occur on one leg only, will not affect the P.D. as much as in the other system. A load with a low power-factor, does not make nearly so much difference with the transformer system, by reason of the very much smaller primary drop. In conclusion, the author regards it as doubtful whether a low-tension four-wire three-phase system will ever pay so long as 115-volt lamps are used—a transformer system being generally preferable. But if high-voltage lamps should improve in efficiency, he regards it as probable that the system considered will have a large field of usefulness.

A. H.

1791. *Problems in Long Transmission Lines.* **F. Breisig.** (Elektrotechn. Ztschr. 20. pp. 383–386, June 1st; 400–403, June 8th; and 417–420, June 15, 1899.)—An elaborate mathematical paper, in which the author develops graphical constructions for the various problems presented by a long power transmission line. The fundamental problem is that in which the P.D., current and phase difference at the far end of the line are given; and it is required to determine the phase difference and find the magnitudes of the P.D. and current at the transmitting end, the resistance, inductance, leakage, and capacity of the line all being taken into consideration. The author devotes a good deal of attention to the question of efficiency, and arrives at the important conclusion that the use of P.Ds. exceeding 15,000 volts would not, in general, much increase the efficiency of transmission, except in the case of very large powers. A. H.

1792. *Underground Mains.* **L. A. Ferguson.** (Elect. World and Engineer, 33. p. 877, June 24th, and 34. pp. 11–13, July 1, 1899. Abstract of a paper read before the National Electric Light Association of New York.)—The various systems of cable laying employed in America are described with tables of costs. In the Edison tube system, copper rods in 20-feet lengths are covered with jute and drawn one, two, or three as required into iron pipes. The pipes are then run in with asphaltum. The cost of laying mains on this system is analysed and compared with the cost of lead-covered cables. The Edison tube is 25 per cent. to 33 per cent. cheaper in capital outlay, but is more liable to faults. The annual cost of maintenance of the Edison tube, amounting to 1·91 per cent. of the capital outlay, is fully analysed.

For feeders, most of the large central stations are abandoning the Edison tube in favour of conduit systems on account of their greater reliability. The cost of laying the following systems is analysed for various number of ducts and different classes of paving: the National; the Francis; the Camp Tile; the Lithocite conduits; and iron pipes. The first four cost 7d. to 8d. per duct per foot under wood paving, 9d. to 1s. under granite setts, 7d. to 10d. under macadam, and 1s. to 2s. 4d. under asphalt. Iron pipes are in each case about 6d. per duct per foot more expensive. For jointing, brick manholes are built which should be well ventilated and drained to the sewage system by non-return valves. Feeder cables may be drawn in 130- to 200-yard lengths. The cost of building manholes and repaving is given for various sizes and classes of pavement varying from 2s. in the larger to 8s. 6d. in smaller sizes per cubic foot. Paper insulation for the cables is coming into use instead of rubber owing to its relative cheapness. Under rivers, submarine cables or tunnels are employed.

Overhead systems, even when allowed, are not found advisable in the long run in urban areas. L. B.

1793. *Short Distance Electric Power Distribution.* **J. Swinburne.** (Eng. Mag. 17. pp. 827–832, August, 1899.)—The author points out that electric driving of workshops is often overlooked through thoughtlessness, and gives instances where it is specially suitable, as when the load is variable or divided amongst a number of separate motors. The use of gas engines is briefly dealt with, and the question of electric supply on a large scale. For variation of speed a multiple wire system with different pressures is suggested. The saving in foundations and other items is noticed, as well as the suitability of electric power for the auxiliary machinery on board ship. A. H. A.

1794. *Rotary Transformers and Storage with Long-Distance Transmission at Hartford.* **W. L. Robb.** (Elect. Rev. N.Y. 34. pp. 344–345, 1899. Paper, read before the National Electric Light Association, New York, May 23, 1899.)—The author describes the plant installed at Hartford, which is supplied from a water-power station eleven miles distant. The maximum power available is 1,200 E.H.P., generated by two 600 kw. alternators, and transmitted on the three-phase system at 10,000 volts. There are two auxiliary steam engines at Hartford of 1,600 H.P., driving a 600 kw. alternator and a 400 kw. two-phase rotary transformer as a generator of direct or alternating currents. The arrangement of the three-wire distribution is described, as well as of the storage battery, which has a capacity of 2,500 H.P. hours at a five-hour rate of discharge. There are two rotaries of 250 kw. each in the battery substation. The battery is charged by varying the ratio of the static transformers. The alternators are always run in parallel, with at least one rotary and the storage battery in connection, so that the whole system is electrically interlocked. The neutral wire of the three-wire system is connected to the middle of the secondaries of the static transformers. No difficulty is found in running the three alternators in parallel, although one is steam-driven and eleven miles from the others. The carbon brushes for the rotaries are plunged at red heat into oil, with great advantage in reducing sparking. Hunting of the rotaries, due to the pulsation of the steam alternator, was entirely cured by attaching copper strips to the pole-pieces of the 400 kw. machine. The plates of the battery are removed when they have lost one-third of their original capacity. Diagrams are given showing clearly the division of load between the rotaries and the battery, and the great advantages of the latter, which also carries the whole load on Sundays. The author strongly recommends the system.

A. H. A.

1795. *Electricity Supply of London.* **A. H. Preece.** (Instit. Civ. Engin. Proc. 134. pp. 5–58, 1899. Discussion, pp. 59–80.)—The author summarises the conditions of supply in the county of London, and gives a table showing the present position of the industry. The average dividend paid in 1897 was 7½ per cent., and the average costs were 56 per cent. of the revenue.

A typical arrangement of generating works is described, and the methods of working in vogue are discussed at length. It is stated that the boilers in use are divided as follows: Water-tube, 75·5 per cent.; Marine, 11·0 per cent.; Lancashire, 5·5 per cent.; miscellaneous, 8·0 per cent.; while the engines are: high speed, 62·5 per cent.; low speed vertical, 25 per cent.; low speed horizontal 6·25 per cent.; special, 6·25 per cent. Direct-coupling is universal. Details are given of a test made on a steam alternator, showing a consumption of 25·1 lb. steam per kw. hour. Distribution systems are next dealt with, and the methods of charging. The total capital expended per 8 c.p. lamp connected is £2 10s. average for direct current, and £3 for alternating, with extreme values of £1 14s. and £4 4s. The capital per kilowatt installed in works varies between £89 and £242. The percentage values of capital expenditure on different items are given for five stations. The details of costs of supply are examined, and stress is laid on the importance of the load factor, which varies between 10 and 22 per cent. approximately. The generating and distributing costs amount on the average to 1½d. per unit for direct and 2d. for alternating current, while management, &c., cost 1d. per unit; the total cost varies between 2½d. and 3d. per unit with large works. The accounts of the City of London (A.C.) and the

Westminster (D.C.) Companies for 1897 are compared in detail. The paper concludes with an appendix giving detailed descriptions of thirteen London undertakings.

In the discussion numerous points of detail were considered, especially steam losses, vibration nuisances, storage, and load factors. The paper is illustrated with figures and a coloured map of London showing the areas occupied by the various supply undertakers. A. H. A.

1796. *Brooklyn Electric Supply System.* **W. S. Barstow.** (Elect. World and Engineer, 34. pp. 13–16, July 1st; p. 54, July 8th; and pp. 89–90, July 15, 1899. Abstract of a paper read before the National Electric Light Association of New York.)—The system employed is a three-phase 25 ∿ with 6,600 volt distribution from the main station at Bay Ridge to twelve substations. In these it is converted by static transformers, rotary converters, or motor generators, into whichever form is most suitable to the local conditions, one, two, or three phase of various frequencies, or direct current at various pressures. Actual determination of the effect of load factor upon central station costs show that with an 80 per cent. load factor they are 70 per cent. less than with a 25 per cent. load factor and the same output. The system of metering the various outputs and tracing the losses is described. Steam auxiliaries, though not individually so efficient as if electrically driven, may be more economical if their exhaust steam be used to heat the feed water. Both should be installed, and the duty distributed between them according to the load to get maximum economy. In the Bay Bridge station the electric auxiliaries take 50 E.H.P. (=67 I.H.P.) for each 2,732 I.H.P. engine or 2·45 per cent.

The alternators are excited from a dynamo driven by a synchronous motor and paralleled with a small battery. The difficulties of paralleling engine-driven alternators are considered, particularly under the influence of synchronous motors or other inductive load. Both overhead and underground feeders are used. When underground the cables are lead and paper-covered three cores laid in tile ducts. Where liable to electrolysis rubber-covered cables are used, protected with asbestos. Owing to resonance effects the pressure at the far end of the feeders frequently rises momentarily to double that registered at the station. It has been found that low insulation cables are often more durable than those of high insulation resistance. Three-fourths of the substation output is continuous current, 3,800 kw. of rotary converters being installed. They do not give trouble by falling out of step in spite of overloads and short circuits. The alternating current distribution is mainly two-phase 60 ∿. The efficiency of the substation plants as measured by watt-meters are as follows. A 400 kw. static transformer and rotary converter substation gives an all-day efficiency of 84 per cent. A synchronous motor plant of 400 kw. driving series arc lighters, an all-day efficiency of 74.3 per cent. The alternating current frequency, phase, and voltage changer (motor generator) on three-quarter load 86 per cent. The constant current transformers for alternating arcs at three-quarter load about 88 per cent. Loss in the high-pressure feeders is 2 per cent. Hence efficiency of transmission and transformation is about 80 per cent. (See also 1899, Abstract No. 762.) L. B.

1797. *St. Helens Electricity Works.* (Electrician, 43. pp. 476–482, July 28, 1899.)—The Corporation originally supplied only single-phase alternating current, but have recently added a continuous current station on account of the tramway load. This station is combined with a dust-destructor plant, but has sufficient independent coal-fired boiler-plant. The Electricity Committee purchase steam from the dust-destructor department and pay for it according to the amount of electrical energy generated. The three-wire lighting mains are at 500 volts between the outers, on which all the generators and the battery are placed, the balancing being effected wholly by balancing dynamos direct coupled to a 16 kw. booster. The plant comprises superheaters, a Klein cooling tower and an oil separator placed between the engine and the condenser. No regulating cells are provided on the battery, the booster being used either positively in the charge or negatively in the discharge of the battery. The overhead construction of the tramways was entirely of English manufacture. E. H. C.-H.

1798. *Combined Lighting and Traction Works.* **J. H. Rider.** (Electrician, 43. pp. 297–298, June 23, 1899. Paper read before the Municipal Electrical Association, June 15, 1899.)—Of twenty-two towns where there are electric trams and the Corporation owns electricity works, fourteen have decided on combined works. Accumulators are at their best in a combined station. Not only do they reduce the amount of tramway plant, but they enable the same engines to be used for lighting and traction at the same time; they take the overlapping of the load in the evening and make a nearly constant load possible. The tramway output can easily be much greater than the lighting output, though the latter may have the larger maximum load.

(Discussion, pp. 298–300.) **Wordingham** strongly favoured the combined station as proposed for Manchester. The same generators will supply current simultaneously for both purposes. **Barnard** could not find any saving in combined stations which would counterbalance the objection of using the high-tension system for the tramways. **Chamen** had found accumulators a snare at Glasgow on account of frequent fogs starting at eight o'clock and lasting for hours. Steam plant to deal with such a case would be cheaper than the very large accumulators required. **Wilmshurst** thought the chief difficulties in the way of combined stations were with the committees. **Giles** stated that at Blackburn a 120 kw. generator was supplying eight cars on a hilly line, and they were steaming no more boilers in the day-time than they did before the tramway load was added. **Quin** had no faith in accumulators. When the time of discharge at a high rate was lengthy, the cost of batteries was more than the cost of the equivalent generating plant, and the arrangement was much less efficient. **Snell** did not agree with the last speaker in saying that the cost of batteries was practically equal to the cost of engines and boilers, but considered the cost per kw. was practically the same as for the steam-dynamos without the boilers. The efficiency of batteries or lighting load under working condition did not exceed 65 per cent. **Rider**, in reply, had found that batteries for a five-hour discharge, which is long enough to take any ordinary peak, cost the same as engines, dynamos, and boilers together, and the chief advantage of the cells was that they gave a twenty-four-hour load.

E. H. C.-H.

1799. *Blackpool Trolley Line.* (Electrician, 43. pp. 474–476, July 28, 1899.)—The generators are two Parsons steam turbo-dynamos of 200 kw. size. The author considers the trolley pole construction here to be particularly unobtrusive. Short brackets on the poles and long arms on the cars have been adopted. The 20-feet trolley arms are constructed to turn a complete circle, and difficulty has arisen in the insulated copper sleeve which this motion necessitates. The arms are constructed of high-grade spring-tempered steel, and are tested with 2,000 lb. at their extremities. E. H. C.-H.

1800. *Electrical Engineering in Switzerland.* (Electrician, vol. 43, 1899.)—Articles descriptive of the Rheinfelden power station (pp. 448–449 and 521–529). The works of Messrs. Brown, Boveri, and Co. (pp. 558–561). The Oerlikon works and the Schaffhausen electricity works (pp. 591–595). Electric Lighting and Traction at Zurich (pp. 623–627). Escher, Wyss and Co.'s works, the Polytechnic, the telephone system and reference to a description of the Sihl electricity works. The Bathausen works at Lucerne, the tramway generating station and the Stansstad-Engelberg, Stansstad-Stans, Stanserhorn and Burgenstock railways (pp. 670–673). The Burgdorf-Thun railway and its generating works (pp. 691–694 and 737–738). The Thun electricity works, the Thun industrial exhibition, and the Interlaken and Jungfrau railway (pp. 738–739).

EDITOR.

1801. *Ashton Electricity Works and Tramways.* (Elect. Rev. 45. pp. 60–65, July 14, 1899.)—An illustrated description is given of the combined lighting, traction, and destructor works of the Corporation of Ashton-under-Lyne. A. H. A.

1802. *Hull Corporation Tramways.* (Electrician, 43. pp. 482–489, July 28, 1899.)—The rails are 94 lb. girder rails with centre groove, rolled in France in 60-feet lengths. The centre groove is adopted to avoid uneven wear of the rails and to give continuous support to the car wheels at the rail joints (which are splayed). The generating station contains an electrically driven three-throw Gwynne pump delivering 1,700 gallons per hour against 150 lb. per square inch, and driven by a 9 H.P. motor which runs normally at 700 r.p.m. on the 500 volt circuit; its speed can be varied from 500 to 800 r.p.m. by shunt and main resistances, while it can further be put on the 220 volt circuit, and regulated between 250 and 400 r.p.m. All the cars have roller bearings. E. H. C.-H.

1803. *Milwaukee and East Wisconsin Electric Railways.* (Street Rly. Journ. 15. pp. 339–352, June, 1899.)—This system of lines comprises 225 miles of track and is therefore among the half-dozen great properties in the States. Realising the importance of a first-class road-bed for high speeds, (45 m.p.h.), the management have lately spent large sums in securing private rights-of-way to cut off curves, in grading the track, &c. The standard city rail is a 6 in. 72 lb. Shanghai section, rolled in 60-feet lengths; it is laid on oak ties at 2-feet centres on a concrete or broken-stone foundation. Two years ago the Falk Company cast-welded some condemned track and thereby have given it an extra five years' life. By the end of this year all the joints within city limits, over 40,000 in number, will be cast-welded. The later work has been done by a local company whose process differs from that of the Falk Company in placing a casing or jacket under and at the sides of the joint. This jacket, into which the metal is poured, is formed by two L-shaped pieces of rolled steel, and adds strength to the cast-iron. Slip joints are provided every 500 feet, and the variation in length with changes in temperature is found to amount to about 1½ in. per 100 feet of track. Hand-car inspection of all high-speed lines is made daily.

During the last two years the overhead construction has been renewed. No. 000 8-trolley wire is the standard and gives absolute satisfaction. The usual difficulties found in other places with this section of wire—in supporting it satisfactorily, running good curves and getting sufficient section—are not regarded as important by the Milwaukee officials. A special clip is used and found very satisfactory. Large section of trolley wire is found the cheapest form of feeder, being uninsulated.

Lighting business is carried on in conjunction with the tramway work, from seven power stations, two of which are merely reserves. A new station, with three-phase transmission, is being built to replace several of these. At present, the cost of production slightly exceeds 1 cent. per kw. hour, of which $0·0066 is for fuel. It is hoped that this figure will be halved in the new station, which will contain two 1,400 H.P. and two 1,100 H.P. Allis-General Electric steam units, besides twenty 100-light Brush arc lighters. The stack is of steel, brick lined, 16 feet diameter in the clear, and 200 feet high: its capacity is 25,000 H.P.

On the long suburban cars, measuring 29 feet over corner posts and 41 feet over all, electric arc head-lights are used, on the ground that power is the cheapest thing found in electric railroading, whilst accidents are the dearest. The arcs search the track a quarter of a mile ahead. The standard car-equipment is with four G.E.-1,000 motors. Tests have shown that the power consumption is less than where two motors of greater aggregate power are used, while repairs are less in spite of the duplication of apparatus. This surprising result is borne out by the 1898 figures which show the low figure of $0·0038 per car mile for repairs of electrical equipment. Several emergency and patrol waggons are kept at different points with the harness suspended over the horses, as with fire-engines. In 1898 the entire cost for maintaining rolling stock up to first-class condition was $0·0091 per car mile, of which $0·0022 was for car bodies, $0·0017 for trucks, $0·0038 for electrical equipments, and $0·0014 for superintendence and sundries.

The twenty-mile run from Milwaukee to Waukesha is regularly made in fifty-five minutes; two Waukesha cars make 380 miles each per day. By rigid punctuality a superior service is given with a longer headway. A surgeon is regularly employed by the company to attend to accidents, and a reserve, amounting to 3 per cent. on the gross earnings, is annually set aside to meet accident claims. The company has 1,673 hands on its pay rolls. The general financial statement for 1898 is given, together with the operating expenses in detail. In the last three years the receipts per car mile have increased by 33 per cent. Unlike most American street railways, sums are annually reserved for depreciation. E. H. C.-H.

1804. *Power Station of the North-Western Elevated Railway, Chicago.* (Street Rly. Journ. 15. pp. 452–454, July, 1899.)—The ultimate capacity of this station is 14,000 H.P., of which half is now installed. The building has a concrete roof and checkered steel-plates, over a basement containing the steam-, exhaust-, and feed-piping, separators, cables, boiler flues, ash conveyors, feed pumps, &c. Three 2000-H.P. Allis-Corliss, cross-compound engines, with cylinders 30 in. and 60 in. by 60 in. stroke, are coupled to Siemens and Halske generators with internal armatures.

Fly-wheels, 25 feet diameter, speed 75 r.p.m. The twenty-four Babcock boilers are fitted with Murphy stokers and coal and ash conveyors. The main steam header is made of 28 in. lap-welded wrought-iron pipe with flanges welded on; it is in three sections, connected to one another by four 8 in. U-shaped steel pipes. Steam pressure, 160 lb. per square inch. All the engines (14,000 H.P.) exhaust into one central condenser of the Weiss counter-current type. The circulating pump only handles the cold injection water, the hot water passing out automatically through a barometric column, or water-leg. It is claimed that this condenser is very economical of power and of water. E. H. C.-H.

1805. *Kingston (Jamaica) Electric Tramways.* **H. E. Raymond.** (Amer. Electn. 11. pp. 317–321, July, 1899.)—The rails (90 lb. in the city, 60 lb. in the country) are laid on steel channel-bar ties, bedded in 8 in. of concrete, which at the rail is raised so as to enclose it half-way up the web. There are six miles of double track, thirty miles of single track. Power is obtained from a reservoir formed by damming up a river 90 feet wide, a mile from the station. Thence an 8-feet pipe of ¼-in. steel, riveted in 6-feet sections, is taken to the power house. In cubic contents, this is one of the largest pipe lines in the world. The generators are three-phase, twelve-pole, with stationary field, giving 300 kw. at 550 volts. Each generator feeds three step-up air-blast transformers, which raise the pressure to 14,000 volts for transmission on a steel pole line to Kingston, where it is stepped-down to 345 volts for the rotaries. The relative field excitations are adjusted so that at about ¾-load the rotaries will operate non-inductively. The rotaries may be started from rest, from either the alternating or the direct current side. The usual custom is, however, to start the generator and rotary from no cycles, and with a full field on the generator. It was found that with weak fields on the generator and rapid acceleration of speed the rotary will pulsate in and out of step, frequently reversing the polarity of the direct current voltage. This is avoided by bringing the generator up to speed slowly, and keeping a strong field on the same. The normal non-inductive, full load alternating current for the rotary is 340 amperes, but only 200 amperes are necessary to start it from rest and bring it up to speed as an induction motor. E. H. C.-H.

1806. *Three-Phase Transmission for Philadelphia Tramways.* (Street Rly. Journ. 15. pp. 353–356, June, 1899.)—The twenty miles of the Philadelphia and Westchester Traction Company are partly fed from a three-phase substation. The generating station contains G. E. units (550 volts) with a 250 kw. rotary converter working off the 'bus bars and giving 380 volts on the alternating side. This is stepped up to 6,600 volts and transmitted 10¾ miles to the substation, where, after passing through aluminium fuses, it is again reduced by three 90 kw. oil-insulated transformers to 380 volts and thence to the rotary transformer. Each rotary has a centrifugal governor arranged to throw the circuit-breaker if the speed rises more than 30 per cent. above normal. The shaft is given a to-and-fro motion in its bearings by a coil and make-and-break device at the end of the shaft. E. H. C.-H.

1807. *Lorain and Cleveland Interurban Railway.* (Street Rly. Journ. 15. pp. 265–273, 1899.)—This line is 18½ miles long over private right-of-way, without curves or grades, and the scheduled time for the whole distance is three-quarters of an hour, including many stops. This involves a speed of 50 m.p.h. for much of the route. Each car has four 50 H.P. motors in order to accelerate rapidly. The line is built according to steam-road practice. Double trolley wire is run throughout. The tension of the trolley against the wire is fixed at the high figure of 35 to 40 lb. The trolley wheels are 7 in. in diameter and do not last more than one week. The cars are 34 ft. 6 in. long, and are each provided with a telephone for connection to boxes placed at each quarter of a mile. Each car runs 340 miles per day and requires on the average 140 amperes at 565 volts. An average record is 3·9 units per car mile, and 21·5 lbs. of coal per car mile. Very complete tests of the generating plant are given and show the difference in efficiencies at steady, rated load, and at a small and variable load, as well as the beneficial effect of increased average, though greatly varying, load. E. H. C.-H.

1808. *Düsseldorf-Krefeld Electric Railway.* **G. Braun.** (Elektrotechn. Ztschr. 20. pp. 432–439, June 22, 1899. Report read before the Deutscher Elektrotechniker in Hanover.)—The total length of this line is 22·2 kilometres. The average speed amounts to 40 km. per hour. The motor car is of the double-bogie type, each truck being furnished with a 35–40 H.P. enclosed gearless motor. A train consists of one motor and two trailer cars. The length of the rails is twelve metres, and the weight 27·5 kg. per metre run. Each motor car is provided with two trolleys of the sliding-contact type. Power is supplied from a generating station at Oberkassel and an accumulator substation at Fischeln, the P.D. amounting to 600 volts. There are three feeding-points; the overhead conductor, which consists of two hard-drawn copper wires 9 mm. in diameter, is divided into six sections, and each section is subdivided into 1 kilometre lengths. The feeders are supported by insulators, mounted on wooden cross-arms, fixed to the poles above the points of attachment of the span-wires. The line was opened in December, 1898. A. H.

1809. *Power for Electric Traction.* **J. G. Scott.** (Elect. Rev. 44. pp. 963–964, June 16th; 1070–1072, June 30th; and 45. pp. 78–80, July 14th; 219–220, August 11th; 384–385, September 8, 1899.)—The tardy but more substantial development of electric traction in Great Britain is compared with that of America. There are at present thirty lines with a total of 260 miles of single track at work in Great Britain. The advantages of combined lighting and traction stations running under various systems are discussed. Many modern lighting stations are being designed on the 440 volt three-wire system in order that the dynamos may be interchangeable. Separate 'bus bars are necessary. The Bradford station is taken as an example. With 220-volt dynamos two may be joined in series for traction work. The Oxford system, which is employed in seven British lighting stations, has not yet been adapted to traction. In alternating stations separate generators are installed for the tramways, as at Blackpool, Dover, and Halifax; or, as at Plymouth, both alternating and continuous current generators may be driven off the same engine shaft. In Glasgow, separate lighting and traction stations are being built; while at Manchester, Wordingham recommends that the two be combined.

Typical daily and annual load curves on both the lighting and tramway systems are given, and their influence on the stand-by plant required explained. The advantage of the combination is much more marked in stations with a small than with a large lighting load. The traction switchboard of the Bradford station is figured and described, as well as the automatic cut-outs and the "Ajax" lightning arrester.

Electrolysis of water-pipes, &c., owing to the earth return, is effectually prevented by the Board of Trade regulations, which are quoted *in extenso.* The switchboard panel, required to make the necessary measurements in conforming to these regulations, is figured and explained. An extraordinary case is quoted from an American source, in which the time of a ten-mile run was reduced from sixty to twenty minutes, by improving the feeder system and the earth return.

The dynamos employed in the Bradford station for either lighting or traction are described, with particular reference to the connections for changing them over and for running them in parallel with compound excitation on the traction load. They are 400 kw. Siemens machines, giving an efficiency by the Hopkinson test of 97·7 per cent. at full load. L. B.

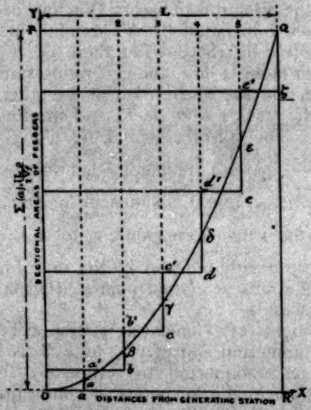
1810. *Electric Traction.* (Cassier, vol. 16. August, 1899.)—Illustrated articles on electric traction by various authors as follows:—**F. S. Pearson**, pp. 257–282, The Latest Developments in Conduit Railways; **R. W. Blackwell**, pp. 283–302, Electric Tramways in Great Britain; **L. W. Serrell**, pp.

303–318, Building an Electric Railway; **J. G. White**, pp. 319–336, Overhead Construction; **C. T. Hutchinson**, pp. 337–356, The Development of the Electric Railway Motor; **T. Reid**, pp. 357–370, Early Traction History; **A. V. Abbott**, pp. 371–380, Electrolysis from Railway Currents; **B. Taylor**, pp. 381–388, The Municipal Ownership of Tramways in the United Kingdom; **J. A. Brill**, pp. 389–424, The Development of the Tram-Car; **M. K. Bowen**, pp. 425–432, Rails and Rail Joints; **L. Bell**, pp. 433–438, Light Electric Railways; **F. J. Sprague**, pp. 439–460, Multiple Unit System for Electric Railways; **G. R. Mair**, pp. 461–486, The Electric Locomotive; **D. C. Jackson**, pp. 487–501, Polyphase Currents for Railways; **C. F. Uebelacker**, pp. 502–506, The Selection of Rolling Stock; **H. Lloyd**, pp. 507–517, Storage Batteries and Electric Railways; **W. J. Clark**, pp. 518–526, American Electric Railways from a Business Standpoint; **P. V. McMahon**, pp. 527–540, The City and South London Railway. EDITOR.

1811. *Return Feeders for Electric Railways.* **B. Böhm-Raffay.** (Zeitschr. Elektrotechn. Wien, 17. pp. 271–274, June 4th; 367–374, July 2nd; 381–385, July 9th; and 407–411, July 23, 1899. Read before the Elektrotechnischen Vereine in Wien, March 1, 1899. Abstracted in detail by A. Mauduit in Écl. Électr. 19. pp. 489–497, July 1, 1899.)—Let there be n cars equidistant from each other along a line, the generating station being at one end of the line, and the furthest car at the other. Let the total resistance of the track return be R, and the total current drawn by the cars I. The fall of potential, V, along the rails will in that case be $\frac{RI(n+1)}{2n}$. With a moderately frequent service, n will be fairly large, so that it is sufficient for practical purposes to take $V=\frac{RI}{2}$ (the value corresponding to $n=\infty$). The fall of potential may be greatly reduced by the use of insulated feeders connected to the rails at certain points. The author considers the following cases:—

1. Track straight: (1) Generating station at beginning of line, and both beginning and end of line, as well as m intermediate equidistant points, connected to station by feeders of such resistance as to maintain the points of connection with the rails at the same potential. The greatest P.D. between any two points in the rails may be shown to be $\frac{RI}{8(m+1)^2}$, or only $\frac{1}{4(m+1)^2}$ of the P.D. when no return feeders are used. If V_f stand for the allowable fall of potential in each feeder, a for the sectional area of any feeder, L for the total length of the line,

and ρ for the resistivity of the copper used, then it may be shown that the total sectional area of copper is $\Sigma(a)=\frac{IL\rho}{2V_f}$, *i.e.*, it is *independent of the number of feeders.* The total volume of copper $\Sigma(v)$ is given by $\Sigma(v)=\frac{IL^2\rho}{3V_f}\left\{1+\frac{1}{2(m+1)^2}\right\}$. This has a maximum value $\frac{IL^2\rho}{2V_f}$ for $m=0$, corresponding to the case of a single feeder running to the far end of the line, and a minimum value $\frac{IL^2\rho}{3V_f}$ for $m=\infty$, corresponding to an infinite number of feeders. It must be noticed, however, that as m increases $\Sigma(v)$ very rapidly approaches its minimum value. The sectional area a_r of the r^{th} intermediate feeder is $\frac{IL\rho}{(m+1)^2V_f}\cdot r$. The following extremely neat construction for graphically determining the sectional areas of the consecutive feeders is given by the author. Draw the rectangle (see fig.) OPQR, in which $OP=\Sigma(a)$, and $OR=L$, and the parabola OQ, whose equation is $x^2=\frac{L^2}{\Sigma(a)}y$. The area of the rectangle represents the maximum volume of copper ($m=0$), and the parabolic area OQP the minimum volume ($m=\infty$). For any finite number of feeders, the volume will lie between these limits. Let there be five intermediate feeders, connected to equidistant points 1, 2, 3, 4, 5. From 1 draw $1a$ parallel to YO, and intersecting the parabola in α; lay off $\alpha a'=a\alpha$, then $a a'$ gives the sectional area of feeder 1, and the rectangle Oa' the corresponding volume of copper. Similarly, through 2 draw $2b$, intersecting the parabola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DISTANCES FROM GENERATING STATION
SECTIONAL AREAS OF FEEDERS
$\Sigma(a)=\frac{IL\rho}{2V_f}$

in β, and lay off $\beta b' = b\beta$; then $b b'$ gives the area, and the corresponding rectangle the volume, of copper for feeder 2, &c.; ζQ is the area of the feeder connected to the extreme end of the line. The graphical method of solution is extended by the author to the case where the feeding-points are not equidistant, and to the problem of finding the feeding-points when the sectional areas of the feeders are given. It is further shown that for *a fixed number of feeders the least volume of copper corresponds to equidistant feeding-points.* (2) Same conditions as in case (1), but with generating station at middle of line. The formulæ in this case are:—

$$\Sigma(a) = \frac{IL\rho}{8V_f} \text{ and } \Sigma(v) = \frac{IL^2\rho}{12V_f}\left\{1 + \frac{1}{(2m+1)^2}\right\},$$

both sides of the line being taken into account. (3) Conditions as in (1), with m feeders, but end of line not connected to a feeder: the maximum P.D. in line $= \frac{RI}{2(2m+1)^2}$;

$$\Sigma(a) = \frac{IL\rho}{2V_f}\left\{1 - \frac{1}{(2m+1)^2}\right\}; \text{ and } \Sigma(v) = \frac{IL^2\rho}{3V_f}\left\{1 - \frac{1}{(2m+1)^2}\right\}.$$

(4) Conditions same as in (1), but neither beginning nor end of line connected to a feeder: maximum P.D. in line $= \frac{RI}{8m^2}$; $\Sigma(a) = \frac{IL\rho}{2V_f}$; and $\Sigma(v) = \frac{IL^2\rho}{3V_f}\left\{1 - \frac{1}{4m^2}\right\}$.

2. Track circular, and *feeders not following line of track*: (1) Line a semicircle, with generating station at centre of arc, and m feeders along radii of semicircle. $\Sigma(a) = \frac{IL\rho}{\pi V_f}$, and $\Sigma(v) = \frac{IL^2\rho}{\pi^2 V_f}$. (2) Line a complete circle, with generating station at centre, and radial feeders: $\Sigma(a) = \frac{IL\rho}{2\pi V_f}$, and $\Sigma(v) = \frac{IL^2\rho}{4\pi^2 V_f}$. (3) Line a complete circle, with generating station on circumference, and feeders along chords: $\Sigma(a) = \frac{IL\rho}{\pi(m+1)V_f} \cdot \frac{\sin\frac{m}{m+1}\cdot 90^\circ}{\sin\frac{90^\circ}{m+1}}$, and $\Sigma(v) = \frac{IL^2\rho}{2\pi^2 V_f}$.

A. H.

1812. *Track Construction in Cincinnati.* (Street Rly. Journ. 15. pp. 433–435, July, 1899.)—The large mileage of the Cincinnati Street Railway Co. was laid five years ago with 95-lb. grooved girder rail spiked to oak ties, bedded in concrete. The officials state that this has given reasonable satisfaction, except that the joints have had to be raised two or three times. Where the soil is porous, the concrete foundations have gone down and the management prefer broken stone foundations in such places. From observation on a reconstructed line, it appears that a grooved rail takes 30 per cent. more power than a step rail. Contrary to expectation, a length of track which was laid with a split rail and broken joints supported on cast-iron chairs laid on concrete pedestals has lasted the five years quite as well as the construction described above. Cast welded joints are standing well, except where a light 6-inch rail was used. The management are thoroughly satisfied with double trolley equipment which has been used throughout. It avoids all danger of electrolysis and is not considered more unsightly than single wire. E. H. C.-H.

1813. *Electric Welding of Rails.* **H. F. A. Kleinschmidt.** (Street Rly. Journ. 15. pp. 362–363, June, 1899.)—In the early days, electric welding produced a change in the nature of the steel, but the writer found a simple process for avoiding this by making the weld from a boss on a bar instead of from a flat bar. As soon as the welding heat is reached, current is cut off and simultaneously heavy pressure is applied while the weld is artificially cooled. The comparatively cold portions of the bar around the weld prevent the more plastic metal from spreading, while the pressure prevents coarse crystallisation. In fact the effect is like hammering the steel.

In the summer of 1898, ten miles of track were welded in Brooklyn in the hottest weather and only 0·5 per cent. of the joints have broken: all the breaks were in old 12-hole rails, and none in 8-hole rails. A 75 kw. booster is used on the trolley circuit and makes a good weld even with only 300 volts. The rails are first cleaned with a sand blast. Fifty miles of track in Buffalo are now being welded electrically. E. H. C.-H.

1814. *Repair Shops at Cincinnati.* (Street Rly. Journ. 15. pp. 360–362, June, 1899.)—The Street Railway Co. of this town has put down very complete repair shops with all possible labour-saving devices. It winds all its own armatures and fields, and makes its own commutators from scrap trolley wire. Each motor has two sets of numbered brushes which are kept in sperm oil when not in use. Each set is put in use every other day in summer and every three days in winter. This practice makes two sets of brushes last a year, and also adds 100 per cent. to the life of the commutator. Trolley wheels are manufactured from a mixture of eight parts of copper and one part of tin by a turret lathe worked by a man, receiving a dollar a day, who finishes 125 wheels a day. E. H. C.-H.

1815. *Riker Motor Cars.* (Electrician, 43. pp. 260–262, June 16, 1899.)—A single motor and differential gearing are used. The ¾ kw. size runs at 1,200 r.p.m. and weighs 80 lb., while the 3 kw. size at 800 r.p.m. weighs 285 lb. Standard types of accumulator are used. An ingenious device attached to the car controller cuts out the battery when fully charged, thus avoiding necessity for skilled labour for this operation. The controller, which operates by series-parallel arrangement of the cells, gives three speeds forward, two backwards, and an emergency brake by use of the motor. E. H. C.-H.

1816. *Motor Cars.* **É. Hospitalier.** (Ind. Élect. 8. pp. 287–305, July 10, 1899.)—Descriptions of various electric motor cars of the French automobile club. EDITOR.

1817. *American Motor Cars.* **T. B. Booth** and **S. S. Sherman.** (Elect. World and Engineer, 33. pp. 575–579, 878–881; 34. pp. 127–129, 173–174, 1899.)—Descriptions in detail of several types of American automobiles. EDITOR.

1818. *Electric Power from Windmills.* **C. L. Crandall.** (Railroad Gazette, 31. p. 318, 1899. Paper presented at the Boston meeting of the American Association for the Advancement of Science.)—The author gives estimates of the lamp-hours per day produced by a ¾ kw. dynamo and a 12-foot aermotor. The paper is illustrated with diagrams showing the relation, found by experiment, between the B.H.P. of the mill and the wind velocity, when the speed is adjusted for maximum efficiency, and various other data. The wind velocities were averaged from the records of the anemometers of the State Weather Bureau at Ithaca, and it was found that the 12-feet motor would provide a minimum of 19 lamp-hours (16 c.p.) per day, while a 16-feet aermotor would give 35 lamp-hours, under the conditions assumed. A. H. A.

1819. *Charging for Alternating Current Supply.* **G. Benischke.** (Elektrotechn. Ztschr. 20. pp. 454–456, June 29, 1899. Report read before the Deutscher Elektrotechniker.)—Consumers using apparatus having a low power-factor (such as induction motors or simple arc lamps in series with choking-coils) increase the cost of production of electrical energy in two ways: (1) by necessitating the use of a larger generating plant, (2) by reducing the efficiency of working. It seems, therefore, only fair that such consumers should be made to pay a somewhat higher price per unit than those using non-inductive loads. The plan suggested by the author consists in making the shunt circuits of the integrating wattmeters supplied to consumers using inductive loads slightly inductive, so as to cause them to register somewhat high. A. H.

1820. *High Efficiency Incandescent Lamps.* **B. L. Montel.** (Zeitschr. Elektrotechn. Wien, 17. pp. 380–381, July 9, 1899.)—From the curves of consumption and candle power, and assuming various prices per lamp and per unit of electrical energy, curves are drawn of the price per c.p. hour at various stages in the life of a lamp. To obtain the maximum economy the lamp should be replaced when this curve has reached a minimum value, usually for high efficiency lamps after 250 to 300 hours only of its life, although it would last much longer before burning out. The cost of the new lamps necessary reduces the apparent economy of high efficiency lamps to from 30 to 60 per cent. of what it would be if the life were as long as that of low efficiency lamps. Details of costs are given. The drop of candle power of high efficiency lamps is also much greater than with those of lower efficiency.

L. B.

1821. *Desaymar High Efficiency Incandescent Lamp.* (Écl. Électr. 19. pp. 497–499, July 1, 1899.)—This paper gives the following figures for watts per candle-power of the "Desaymar" lamp recently put on the market in Paris by De Marçay & Co.:

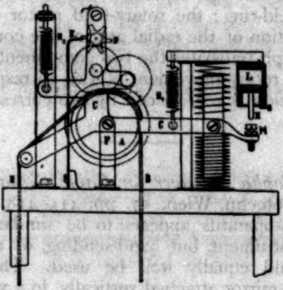
2·5 to 2·7 watts for lamps of 10 C.P.
2·3 „ 2·5 „ „ 16 „
2 „ 2·3 „ „ 20 „
1·8 „ 2 „ „ 32 „

The life of the lamps is guaranteed for at least 600 hours. The watts per candle necessarily increase with the life of the lamp, but not very largely; thus a 20 c.p. lamp after burning 1,100 hours only takes 2·8 watts per c.p. In these lamps a rather long filament is employed which is wound in a spiral form, and a cylinder of enamel covered with a thin coating of glass is placed along the axis of the spiral. The makers attribute to this cylinder a certain importance in increasing the power of the light for a given expenditure of electrical energy, as it will give a better distribution of the light by reason of the multiple reflections.

E. C. R.

1822. *Large Incandescent Lamp.* (Amer. Electn. 11. p 340, July, 1899.)—This article describes what is stated to be the largest glow-lamp ever made. It is 5,000 candle power, and constructed for use in a lighthouse, as its fog-penetrating properties are much superior to those of an arc-lamp. The lamp is of the two filament type, the two filaments being in parallel and taking 236 volts, the power taken is about 3 watts per c.p., the total power being therefore about 15 kilowatts. It is made by the Bryan-Marsh Company. E. C. R.

1823. *Arc Lamp.* (Elekt. Runds. 16. p. 187, 1899.)—This is a description of a focussing arc-lamp mechanism made by Messrs. Siemens and Halske. Steady burning is attained by great freedom of motion and sensibility in the regulating mechanism. Friction is overcome by introducing two spiral springs H_1 and H_2 acting upward on either side of the pivot F, thus balancing each other and supporting the weight of the moving parts. Also by leaving the dash-pot spindle N normally disconnected from the moving lever C, and only coming into play to prevent extreme variations of the arc. L. B.



TELEGRAPHY AND TELEPHONY.

1824. *Telautograph with Rotary-field Drive.* **F. J. Patten.** (Elect. World and Engineer, 34. pp. 233–234, August 12, 1899.) —Devices of the pantagraph type, for transmitting and receiving line drawings, have the general defect that the mechanism works step by step, and thus produces a more or less serrated line in place of a smooth original. To obviate this, the author adopts a motor system of the rotary-field type, driven by direct current applied to a gramme ring in such a way as to produce a rotating magnetic field which operates upon a closed-coil armature in synchronous rotation with the field. In place of commutator-bars, a circular mercury commutator is used; it consists of an ebonite disc having four concentric troughs containing mercury. A revolving radial knife-edge connects the mercury commutator at different points through separate wires to the respective parts of the motor field-ring; the rotary-field motor consequently reproduces the motion of the radial arm of the commutator. The sending pantagraph translates the two components of the motion of its stylus into rotary movement of two corresponding commutators. The motion is reproduced by two corresponding motors.

R. A.

1825. *Photographic Receiver for Cable Signals.* **J. Pinter.** (Zeitschr. Elektrotechn. Wien, 17. pp. 415–418, July 30, 1899.) —The sending apparatus appears to be similar to the Delany brush-contact instrument, but hand-sending, or any of the auto-transmitters, could equally well be used. The receiver is a telephone, with a mirror attached vertically, in a very delicate and effective manner, to the diaphragm. Light from a bright point is reflected from the mirror, giving an image on a rotating cylinder which progresses axially along a screw; the cylindrical surface is covered with photographic paper, upon which, when the mirror is at rest, a spiral line is formed. In order mechanically to magnify the motions of the diaphragm, and to convert them into angular deflections, the mirror is hinged at the top and actuated by a rod lightly touching it at the middle; this rod projects from the middle of the diaphragm to which it is rigidly attached. The "hinge" suspension is simply a magnetic contact between the top of a thin iron plate fixed to the back of the mirror, and a two-point pole of a magnet, the two points being close together in a horizontal line. The second pole of the suspension magnet magnetises a light, straight, vertical spring, the pointed top of which extends to the middle of the back of the mirror; this spring is attached just below its top to the end of the rod which projects from the telephone diaphragm. It is necessary to eliminate the effect of thrusts due to the natural period of the telephone diaphragm; the author, therefore, rates the auto-sender so that the electric impulses are of the same period as the fundamental of the diaphragm; he claims that, with a condenser between the terminals of the telephone, he can then effectively damp the natural "after-swings" of the diaphragm. A photograph of "slip" obtained by the apparatus is a proof of the capabilities of this type of instrument. There seems to be absolutely no limit to the "speed" to be attained by photographic recorders; the author mentions 600 words as being recorded in twenty-two seconds (German words). R. A.

1826. *Benches for Telegraph Apparatus.* **E. Lönnqvist.** (Journ. Télégraph, 23. pp. 58–60, 1899.)—In this article the author concludes his description of the arrangements of telegraphic apparatus adopted by the Director-General of Swedish Telegraphs (see 1899, Abstract No. 1107). Details and drawings are given of the benches that are found most convenient for instruments. The legs of the benches are slotted so that the wires can be brought up inside them. For the purpose of further secreting the connections, the top of the bench is made hollow. The switches are hidden to protect them from dust and mechanical injury. R. A.

1827. *Translator for the Printing Telegraph.* (Journ. Télégraph, 23. pp. 49–52, 1899.)—The relay at Brégenz, making it possible to use Baudot's telegraph between Paris and Vienna, is an improvement on the translator at Turin which works the Paris-Rome installation. It is described in detail. M. O'G.

1828. *Morse Sounders.* (Archiv. Post Tele. 9. pp. 427–433 1899, and Elektrotechn. Ztschr. 20. pp. 370–371, 1899.)—An account is given of the Morse sounder as used by the British Post Office, and it is recommended for adoption in Prussia and Germany. The two articles are practically identical. R. A.

1829. *Electrical Radiation.* **A. V. Abbott.** (Elect. World and Engineer, 33. pp. 616–617, 652–653, 701–702, 749–750, June 3rd, 802–803, June 10, 1899.)—This is a compilation including an account of the ordinary apparatus used in wireless telegraphy, and some idea of electrical radiation. R. A.

1830. *Wireless Telegraphy.* **I. Kitsee.** (Elect. World and Engineer, 33. pp. 871–873, June 24, 1899.)—A telephone receiver substituted for a coherer was found to respond to electric waves, even when the diaphragm was of rubber and the coil removed. The law deduced is that the air in proximity to the conductors conveying high-frequency waves acquires a pulsatory motion, which it may transmit to a diaphragm. The rigid chamber behind the diaphragm should be connected to two terminals in contact with media at different potentials, which media may be the air or the earth. M. O'G.

1831. *Simultaneous Telegraphy and Telephony.* **C. Selden.** (Elect. Rev. N.Y. 34. p. 332, 1899. Paper read before the Railway Telegraph Superintendents' Association, Wilmington, May 17, 1899.)—Van Rysselberghe reduces the abruptness of the Morse signal by an inductive resistance called a graduator, and bridges the Morse keys, when open, by a capacity so that a receiver is not affected by the make and break. Two telegraph wires are used in preference to an earth return, and the telephone instruments at each end are connected to them through condensers. Commercial conversation was held over 200 miles of iron wire. It is regrettable that no call exists for the telephones on the "simultaneous" system other than the use of the Morse telegraph. M. O'G.

1832. *Single Exchange Line for Five Subscribers.* **J. H. West.** (Journ. Télégraph, 23. pp. 52–57, 1899.)—By means of a special commutator relay for each group of five subscribers the exchange can call up any of the five without disturbing the others and without any other being able to ring in or listen in. A continuous signal is given to the four others that the line is busy. Since the average number of connections is twelve a day, the five subscribers' calls will rarely coincide and the rent can be reduced to two-fifths of its present figure with profit. The action and instruments at the exchange are unaltered, except that to call No. 5, five impulsive currents must be sent into the relay; to call No. 4, four impulses, and so on. M. O'G.

1833. *Germain's Loud-Speaking Transmitter.* **G. Dumont.** (Électricien, 17. pp. 305-308, 1899.) — Carbon granules are replaced by another semi-conducting substance so that 20 volts may be safely applied. The container is a cylindrical box whose two ends are connected by a flexible membrane. M. O'G.